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MANUFACTURING TECHNOLOGY PROGRAMS BEING UNDERTAKEN BY THE DEPARTMENT OF DEFENSE AND THE DEPARTMENT OF COMMERCE

HEARING

BEFORE THE

SUBCOMMITTEE ON
DEFENSE INDUSTRY AND TECHNOLOGY

OF THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

ONE HUNDRED SECOND CONGRESS

FIRST SESSION

APRIL 9, 1991

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MANUFACTURING TECHNOLOGY PROGRAMS BEING UNDERTAKEN BY THE DEPARTMENT OF DEFENSE AND THE DEPARTMENT OF COMMERCE

TUESDAY, APRIL 9, 1991

U.S. SENATE,
SUBCOMMITTEE ON DEFENSE INDUSTRY AND TECHNOLOGY,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

The committee met, pursuant to notice, at 9:31 a.m. in room SR-222, Russell Senate Office Building, Senator Jeff Bingaman (chairman of the subcommittee) presiding.

Committee members present: Senators Bingaman, Coats, and Smith.

Professional staff members present: William H. Smith.

Minority staff members present: Jonathan L. Etherton, professional staff member.

Staff assistants present: Elizabeth Ann Harlow and Camden Jones.

Committee members' assistants present: John P. Gerhart, assistant to Senator Bingaman; Leon S. Fuerth, assistant to Senator Gore; Melvin G. Dubee, assistant to Senator Byrd; Eric H. Thoemmes, assistant to Senator Coats; Ross Lindholm, assistant to Senator Mack; and Thomas L. Lankford, assistant to Senator Smith.

OPENING STATEMENT OF SENATOR JEFF BINGAMAN, CHAIRMAN

Senator BINGAMAN. We will call the hearing to order.

The subcommittee meets today to receive testimony on defense manufacturing technology and how it may be effectively used to support the manufacturing capabilities of the country.

The Defense Department has been a consistent leader in introducing new technology in the manufacturing area through its MANTECH program. Last year, on April 2, this subcommittee received testimony from Mr. Dick Donnelly, representing the Office of the Secretary of Defense, and Mr. Willis Willoughby representing the Department of the Navy, concerning their activities to enhance defense manufacturing technology. At the hearing, Mr. Donnelly testified that the Defense Department was restructuring its MANTECH program and, as a part of that effort, was developing a top-down strategic plan to better guide service and agency MAN-

TECH investments and improve administrative oversight for its programs.

One purpose of the hearing is to update the subcommittee on progress achieved by the Office of the Secretary of Defense working with the services and the agencies over the past year toward achieving their objectives.

The second purpose of today's hearing is to obtain testimony on how our various centers that have been funded through Department of Defense, Department of Commerce, and by the National Science Foundation can be better used to upgrade America's manufacturing capability.

In November of this last year, I had the opportunity to visit in Japan. We had an opportunity to become informed on some of the manufacturing extension efforts occurring in that country and the efforts to move ahead in manufacturing technologies. We hope, maybe, during the question and answer period today, we can discuss the position of our Government on some of the proposals that have been made in that respect.

I was disappointed to see that the Department of Defense has again reduced the overall MANTECH funding level in the budget submitted this year, and has chosen to request no funding for the newly established MANTECH line item. I hope that in the presentation by Mr. McMillan, we can shed some light on the Department's rationale in establishing its level for the MANTECH request this year.

Last year, to address some of the more serious management issues affecting the MANTECH program, I introduced the Defense Manufacturing Technology Act of 1990. The bill was subsequently adopted as part of the Fiscal Year 1991 National Defense Authorization Act which the committee reported out to the Senate floor. It directed the Defense Department to prepare a National Defense Manufacturing Plan, to coordinate its plan with other Federal departments and agencies, to promote current engineering and computer integrated manufacturing, as well as promote basic research in manufacturing technology. Again, that is an issue that we want to discuss in today's questions.

The first witness this morning is Dr. Robert White, who is the Under Secretary of Commerce for Technology. It has become increasingly apparent that the interests of the Department of Defense and the Department of Commerce, concerning advance manufacturing technology are converging. These two Departments need to work closely together in the future if they are to satisfy the Nation's national security and economic competitiveness needs.

Dr. White has been particularly instrumental in developing the Commerce Department's program to establish manufacturing service centers. These centers make available state-of-the-art flexible manufacturing equipment which small firms can then use to do jobs which they could not otherwise perform.

The second witness is Mr. Colin McMillan, who is the Assistant Secretary for Defense for Production and Logistics, with the responsibility for policy development and program oversight of Defense Department's Manufacturing Technology Program. We look forward to his testimony on the progress being made on achieving

the goals that were set forth in last year's hearing and in implementing the provisions of last year's manufacturing technology act.

Our third witness is the president of one of those small manufacturing firms which is the target of all of this well-intended, governmental support. Mr. Larry Rhoades is president of Extrude Hone, a company located in Irwin, Pennsylvania, which employs slightly less than 100 persons. Mr. Rhoades' company is recipient of two Air Force manufacturing technology contracts. One nearing completion is to develop a new process to finish high-precision cavities while maintaining very tight tolerances and low scrap rates. The second is to develop a new type of automated, high-precision measuring equipment that avoids making physical contact with the item being measured. Success in either of these programs could result in the United States regaining market share, which has been lost to the United Kingdom.

[Senator Bingaman's prepared statement follows:]

PREPARED STATEMENT OF SENATOR JEFF BINGAMAN

The subcommittee meets today to receive testimony on defense manufacturing technology and how it may be more effectively used to support improving America's manufacturing capabilities in all areas.

The Department of Defense has been a consistent leader in introducing new technology in the manufacturing area through its MANTECH program. Last year, on April 2, this subcommittee received the testimony of Mr. Dick Donnelly representing the Office of the Secretary of Defense, and Mr. Willis Willoughby representing the Department of the Navy, concerning their activities to enhance defense manufacturing technology. At this hearing Mr. Donnelly testified that the Defense Department was restructuring its MANTECH program and, as a part of that effort, was developing a top-down strategic plan to better guide service and agency MANTECH investments and improve administrative oversight.

One purpose of this hearing is to update the subcommittee on progress achieved by OSD working with the services and agencies over the past year toward achieving their objectives.

Mr. Willoughby testified on the Navy's efforts under their MANTECH program to establish manufacturing centers of excellence supporting electronics, composite materials, metalworking and general manufacturing research. One of those centers, the Electronics Manufacturing Productivity Center, is located in the State of our distinguished ranking member, Senator Coats.

A second purpose of today's hearing is to obtain testimony on how these centers and others established by other DOD components, by the Department of Commerce, and by the National Science Foundation can be better used to upgrade America's manufacturing capability. I believe centers such as these are especially important in helping our small and medium sized manufacturing firms to remain competitive.

In November of the past year I again visited Japan. This was my fourth such trip during which I continued my personal assessment of the Japanese technological and manufacturing strengths and weaknesses. As a result of this trip, plus inputs received from many other sources, I have become even more convinced that the competitive advantage lies more with those who take advantage of technology than with those who initially develop it. Further, I believe that this is equally true in the defense and commercial sectors.

I am also more convinced than ever that the United States is falling behind other leading industrial nations in the invention and application of new manufacturing technology in many sectors. This problem becomes particularly acute in small and medium sized firms, those with fewer than 500 employees. These firms, which are the large majority of all firms in the United States, account for over one-half of all manufacturing value added in America.

The United States Federal Government devotes less than 2 percent of its research and development funds on manufacturing research, and even less is devoted to manufacturing technology. Last year the Congress gave a strong boost to the DOD MANTECH programs both through added funding and new legislation. In recognition of the high leverage that manufacturing technology research gives, the Congress added $154 million to the overall administrations budget request. Based on an

initiative of this subcommittee, a new program element initially funded at $50 million was established to support work in longer-range manufacturing technologies.

I was disappointed to see that the Department has again reduced the overall MANTECH funding level in this year's budget request, and has chosen to request no funding for the newly established MANTECH line item. I hope that Mr. McMillan will be able to shed some light on the Department's rationale in establishing its MANTECH budget request for this year.

Last year, to address some of the more serious management issues affecting the MANTECH program, I also introduced the Defense Manufacturing Technology Act of 1990. This bill was subsequently adopted as a part of the Fiscal Year 1991 National Defense Authorization Act. It directed the Defense Department to prepare a national defense manufacturing plan, to coordinate its MANTECH program with other Federal departments and agencies, to promote concurrent engineering and computer integrated manufacturing, and promote basic research in manufacturing technology.

The act as adopted also directed DOD to work with the individual States in establishing or upgrading their manufacturing extension programs to help small and medium sized manufacturers. Modeled after the well-established Agriculture Extension Service, these programs use engineers experienced in industrial practice and the latest manufacturing techniques to help these firms solve their production problems and to improve worker training.

This morning we will have testimony from three distinguished witnesses.

The first witness this morning is Dr. Robert White who is the Under Secretary of Commerce for Technology. It has become increasingly apparent that the interests of the Department of Defense and the Department of Commerce concerning advanced manufacturing technology are converging. These two department's must work more closely together in the future if they are to satisfy the Nation's national security and economic competitiveness needs.

Dr. White has been particularly instrumental in developing the Commerce Department's program to establish manufacturing service centers. These centers make available state-of-the-art flexible manufacturing equipment which small firms can then use to do jobs which they could not otherwise perform. The centers often also work closely with local universities or community colleges and tend to become "teaching factories" for training the regional manufacturing workforce. The Department of Defense has recently announced its own plan to introduce more flexible computer integrated manufacturing centers. I believe that it is mandatory that the Defense and Commerce Departments work together to achieve maximum benefits from their respective programs.

The second witness, Mr. Colin McMillan, is the Assistant Secretary of Defense for Production and Logistics, with the responsibility for Policy Development and Program Oversight of the Defense Department's manufacturing technology program. We look forward to his testimony on the progress being made on achieving the goals they set forth in last year's hearing and in implementing the provisions of last year's Manufacturing Technology Act.

Our third witness is the president of one of those small manufacturing firms which is the target of all of this well-intentioned support. Mr. Larry Rhoades is President of Extrude-Hone, a company located in Irwin, Pennsylvania which employs slightly less than 100 persons. Mr. Rhoades' company is the recipient of two Air Force manufacturing technology contracts. One, nearing completion, is to develop a new process to finish high precision cavities while maintaining very tight tolerances and low scrap rates. The second is to develop a new type of automated high-precision measuring equipment that avoids making physical contact with the item being measured. Success in either of these programs could result in the United States regaining marketshare lost to the United Kingdom.

Senator BINGAMAN. Before we begin with any of the witnesses, I would like to, of course, defer to our distinguished ranking member, Senator Coats for any opening comments that he would like to make.

Senator COATS. Thank you, Mr. Chairman. I will submit a formal statement for the record and just briefly indicate that, as this is my first subcommittee hearing as a ranking member, I look forward to testimony of the three witnesses which we have before us and look forward to working with you, Mr. Chairman, as we examine what I

think is an important component of the defense budget and defense programs.

Clearly, MANTECH has a demonstrated record of success and I think examining where we currently are and where we need to be going, raising some valid questions relative to Department of Defense budget proposal for the next fiscal year in terms of how it relates to MANTECH programs, is appropriate at this time.

So I look forward to the testimony of our witnesses. I look forward to examining what has been an important program and hopefully will continue to be an important program.

[The prepared statement of Senator Coats follows:]

PREPARED STATEMENT OF SENATOR DAN COATS

Mr. Chairman, I want to join you in welcoming our witnesses this morning. This is my first hearing as ranking minority member, and it is appropriate that we begin the subcommittee hearings with a review of the management of manufacturing technology programs in the Department of Defense. Since the MANTECH program began in 1947, the return has been several times the amount of the original investment. Process technologies developed using MANTECH funds have found applications in a number of defense and commercial manufacturing sectors and have had a significant impact on the productivity of U.S. industry.

As we face the long-term prospect of sharply declining defense budgets, manufacturing technology programs are an important tool for reducing the costs of defense programs. Effective dissemination of the results of research can strengthen the ability of United States to compete in the world marketplace. Therefore, it is incumbent on this committee to ensure that adequate funding is provided for the program and that we structure the management of the program to reduce duplication and increase efficiency.

Last year, under your leadership Mr. Chairman, the Senate initiated action that resulted in section 823 of the Defense Authorization Act for Fiscal 1991. This section provided a statutory basis for more centralized MANTECH policy in the Department of Defense. The section also established a National Manufacturing Technology Plan to force a more effective planning and prioritization process for allocating funding for manufacturing technology programs. I look forward to hearing from Mr. McMillan on the Defense Department's progress implementing that mandate.

The Department of Commerce is the lead agency managing similar programs involving commercial manufacturing. Such programs will play a key role in fostering the incorporation of advanced manufacturing technologies by medium and small businesses in the United States. Mr. White's testimony should be useful in directing us toward ways of ensuring maximum coordination between the Department of Commerce and the Department of Defense in their respective programs.

As we contemplate changes to the management structure and the funding of the MANTECH program, it is essential that we get the perspective of those in the private sector who have carried out research under the program. For that reason, I am pleased that Mr. Rhoades has agreed to give us the benefit of his experience working with the Department of Defense.

Mr. Chairman, keeping the momentum behind manufacturing technology programs is one of the most important challenges we face this year. I look forward to working with you in meeting it.

Senator BINGAMAN. Thank you very much.

Dr. White, why do you not go ahead and summarize your testimony. We will then have some questions of you and then proceed with Mr. McMillan's testimony.

STATEMENT OF HON. ROBERT M. WHITE, UNDER SECRETARY OF COMMERCE FOR TECHNOLOGY

Dr. WHITE. Thank you, Mr. Chairman.

Because I do not usually have the opportunity to appear before the Armed Services Committee, I have submitted a comprehensive statement about advanced manufacturing in general and Com-

merce's manufacturing programs in particular. And because I hope to be invited back someday, I will just summarize it.

I suspect that many Americans who can still remember World War II cannot understand how a nation that managed to, almost overnight, convert itself to a wartime economy, turn out such a prodigious amount of munitions and armaments, and then go on to unchallenged world economic leadership when the guns fell silent, could have lost its manufacturing edge.

Well, the reasons are complex. But to a large degree, we were victimized by our own success. Given the devastation of so many other nations in World War II, the United States turned inward, technologically speaking. It reaped enormous success by mass producing undifferentiated goods for the domestic market, figuring that if it was good enough for us it was good enough for anybody else, by ignoring external scientific technological developments and by training workers to do narrow, specialized jobs, rather than building a pool of multi-skilled workers, adept at working with new and changing technologies in the work place.

In effect, the traditional, American manufacturing model was the mass production model. To be sure, it was a model that was advanced for its time and made us a world class industrial power. But it was also a model whose limitations were probably best summed up in Henry Ford's famous line, "The customer can have any color he wants as long as it's black."

In today's competitive world, it is a model that is suitable only for simple products where the batches are huge and the life cycles are long. But I do not see our economic destiny tied to such products, examples of which include beverage cans, paper clips, erasers, and so forth, and from the defense point of view, very small arms ammunition.

Yet a lot of people think of this model when they think of manufacturing—Lucille Ball trying frantically to keep up with a conveyor belt. In fact, a new age has dawned, made possible by the development of enabling technologies that are characterized by the use of digital, as opposed to analog, data elements.

Numerically controlled machine tools were the first such technology, followed by computer-aided design and computer-aided manufacturing. Through these tools, manufacturing today has increasingly come to revolve around complex products, flexible processes, speed to market, and quality levels that exceed anything mass production could have imagined.

This is the model that will prevail in all products of substantial complexity and high value, such as aerospace products, automobiles, and weapons systems. This new model, which we call lean production, can make it possible to provide small batch production for a wide variety of products with almost no down time and with the same per unit cost for batches of 1 or 1,000.

Some companies using these systems have been able to double the output per labor hour and reduce total product cost by as much as 75 percent. Beyond improving quality and lowering costs, advanced systems also make it easier to introduce new products and make incremental product improvements. They permit the constant refinement that ultimately make circuits denser and engines more efficient.

Unlike old style, inflexible systems, they are an essential part of the innovation, or technology commercialization, process—no small matter for a nation that wins Nobel prizes but watches other nations create products from our discoveries or capture markets that we pioneered.

Although some of our larger companies are becoming aware of the advantages of flexible manufacturing systems, and are investing in them, our smaller ones, the ones on whom our large companies are dependent for machinery and components, are not as quick to adapt.

In countries such as Japan, half the systems are purchased by small and medium-sized companies. And even when we do purchase them, we find that our competitors can turn out about 10 times the number of products on each piece as we do.

Without dramatic improvements, U.S. companies may become increasingly dependent on foreign sources for components. U.S. companies may find it competitively disadvantageous to be so far away from their sources, given higher inventory and related costs that would result, and the advantages of a two-way technology flow between the larger and smaller companies and vice versa, will be lost.

Why are we so slow to adapt? To some measure, the change that is required is not a simple one. I have attached to my formal statement, a chart that describes the differences between traditional manufacturing and the lean production that advanced manufacturing makes possible.

As it demonstrates, we are talking about changes in how a company sees itself, its product, its customers, how it is organized, its culture, its approach to quality, everything. In effect, the change requires companies to reinvent themselves. In addition, some of the key determinants of competitiveness, such as quality, just in time delivery, and the ability to change product rapidly, are intangibles that cannot be easily quantified and in fact, are largely ignored by traditional accounting methods.

They continue to focus on traditional measurements of the cost of production, such as labor and material, even though today these are a fraction of the total cost rather than on such costs as materials control, quality assurance, process engineering, and software development.

Accordingly, the Technology Administration at Commerce is attacking the problem from both a business as well as a technological point of view. These activities are spelled out in some detail in my formal statement. But just to summarize them, from the business perspective, we have developed and are championing the concept of shared flexible, computer-integrated manufacturing facilities.

This is essentially a manufacturing service center that has state-of-the-art, off-the-shelf, flexible manufacturing systems and leases manufacturing time to small firms. Most funding is from private sources, with some State support. Through them, small firms can learn about advanced technologies, provide a wider range of products, respond to sudden changes in demand, serve both civilian and military needs, and achieve unprecedented levels of quality, all with no initial capital investment. We hope to have fostered about 200 of these facilities by the year 2000.

In addition, we are working with Treasury, companies, and the financial community, including pensions funds, to get a better understanding of the root causes of underinvestment in technology and to examine accounting standards that make it harder for firms to take the long term view.

Now from a technology perspective, our principal tools for catalyzing private sector interest in advanced manufacturing include the following: first, there is the Malcolm Baldrige Quality Award which promotes quality awareness and publicizes successful quality strategies.

There is NIST's Automated Manufacturing Research Facility, which is our major technical thrust related to the interfaces and standards for the next generation of computer-aided manufacturing.

There is work with DOD on the development of the Product Data Exchange Standard, known as PDES. These are standards that will enable manufacturers to express all useful information about a product's characteristics in a digital format that will be available to suppliers, contractors, and other support groups, and will facilitate the integration of product design and manufacturing.

We have new outreach programs, such as our manufacturing technology centers, or the MTC's, of which there are now five, through which we transfer to the private sector leading edge manufacturing technologies.

There is also our Advanced Technology Program, ATP, which promotes the commercialization of pre-competitive generic technologies, including manufacturing technologies.

In concluding, Mr. Chairman, let me just note that Commerce and DOD share a mutual interest in the extent to which America adapts to the new manufacturing technologies. Commerce, because of its broad economic responsibilities, and Defense, because of our national security, depend upon it. DOD, like many agencies, faces downward pressure on its budget. That means fewer new systems and greater emphasis on upgrading existing military systems in the field, on reducing costs and reducing our reliance on foreign suppliers for essential components.

It also means that DOD will have to concentrate its efforts on those areas that truly serve our national security interest. It cannot do everything. If recent events in the Middle East are any indication, manufacturing excellence in certain key areas will be vital, such as semiconductors, computer networks, and precision robotics.

And if that is so, then I would anticipate that the line between military and civilian markets will grow increasingly blurred and that the advances in weaponry will increasingly be led by what takes place in consumer products. Thus, the line between purely military and purely civilian research will also grow increasingly blurred. There should be greater commercial bang for each Defense dollar spent and vice versa.

But we should also remember that as the two arenas become increasingly intertwined, efforts to control technology will become increasingly difficult. Those who cannot tolerate any restriction on access to R&D and those who see any sharing of information as in-

imical to our security interests, will have to reach some new accommodations.

In short, Mr. Chairman, the transition that is occurring and must occur in manufacturing will have enormous implications for our economy, for our security, and beyond that, for so many other things—for innovation, for our approach to international cooperation, for fiscal priorities, for how we educate our young people and train or retrain our labor force, and just about all aspects of our national life.

Thank you very much.

[The prepared statement of Dr. White follows:]

PREPARED STATEMENT BY ROBERT M. WHITE, UNDER SECRETARY OF COMMERCE FOR TECHNOLOGY

Mr. Chairman and members of the subcommittee, I am delighted to have this opportunity to appear before you to discuss the importance of our manufacturing technology programs and their relation to our national defense. There is growing evidence that the interests and activities of the Departments of Commerce and Defense in advanced manufacturing technology will increasingly converge. And even if the lines don't quite meet, they will at least move in the same direction.

Historically, there has always been a strong connection between the needs of the military and the way manufacturing has developed in the United States. Mass production-based manufacturing owed its birth in large measure to the development of machine tools at England's Woolwich Arsenal, tooling and factory organization techniques developed at the Colt Armory in Hartford that allowed unskilled labor to assemble muskets, and the great mass production plants at Ford and GM and the munitions and armaments plants during World War II.

To some degree, the mass production model will continue to prevail for simple products where the batches are large and the life cycles are long, such as small arms ammunition, beverage cans, pencils, and paper clips. That is not to say that such industries can ignore the advantages of advanced manufacturing, which can greatly enable them to meet surge demand or which, in the event of a national emergency, can permit entire civilian-oriented industries to convert to defense production in days or weeks. But we must not allow our thinking or vision to be governed only by mass production models.

Rather, it should be shaped by a recognition that a new age has dawned made possible by the development of enabling technologies that are characterized by the use of digital, as opposed to analogue, data elements. Numerically controlled machine tools was the first such technology, followed by computer aided design and computer aided manufacturing.

Through such tools, which eventually made the concept of Flexible Manufacturing possible, manufacturing today increasingly revolves around complex products, flexible processes, speed to market, and quality levels that mass manufacturing could only dream about. This new paradigm will become dominant in all products of substantial complexity and high value, such as aerospace products, automobiles, and weapons systems. As such, it commands our attention, for firms that fail to adapt to the changes that are transforming manufacturing will be consigned to history.

Given the enormity and complexity of these developments, I believe I can be of most assistance to the subcommittee by inviting your attention to five key questions: Why should Commerce care about advanced manufacturing technology? What are the difficulties in ensuring its widespread adoption by industry? Why should any of this matter to DOD? What is the Technology Administration doing about this? What are the implications for agencies such as Commerce and DOD?

First, why does Commerce care? Manufacturing accounts for about 23 percent of GNP and about 75 percent of all U.S. exports. It accounts for about 19 million jobs. It is through manufacturing that we add value and technology to raw material and transform it into valuable products—products that satisfy our own material wants, products that can compete in the international marketplace, products that are essential for our national security. Other sectors, such as the service sector, are heavily dependent on manufacturers both as customers and as suppliers. Simply stated, I believe manufacturing is and will remain essential if we are to continue enjoy a high standard of living.

And the benefits are not purely economic. A strong industrial economy is an unassailable advertisement for the benefits of our political and economic ideals and, as such, underpins our moral authority and leadership.

I believe that if we do not take advantage of new manufacturing technologies, our future will be seriously compromised. The dynamics of competition are changing. It is now waged on a global scale. It demands products of world-class quality. It demands as never before the ability to control inventory and other costs. Given the rapid pace of technological change and the shortening of product life cycles, it demands the ability to respond quickly to changing market needs and new technologies. It demands the ability to satisfy the needs of individual customers, and not assume they are all "fungible."

Programmable automation, such as flexible manufacturing systems, can provide these benefits. They make it possible to provide small batch production of a wide variety of products for either the civilian or defense market, with almost no down time, and with the same per unit cost for batches of one or one thousand. Some companies using these systems report they have been able to double the output per labor hour and to reduce total product costs by as much as 75 percent.

Beyond improving productivity and quality and lowering costs, advanced manufacturing technology also reduces the time, cost, and difficulty of introducing new products and making incremental product improvements. That is, it is an integral part of the innovation process. A nation that wins Nobel prizes for breakthroughs in the lab while watching other nations walk off with the commercial rewards from those breakthroughs must recognize this reality.

Old-style inflexible manufacturing facilities, besides being inefficient and costly to maintain, can become a deterrent to the introduction of product changes and to progress. But mastery of modern manufacturing processes gives one the ability to turn a product over and over quickly and efficiently. It permits the constant refinement that ultimately makes circuits denser or engines more efficient. In other words, manufacturing excellence is rapidly proving itself to be an essential part of the innovation, or technology commercialization, process.

Mr. Chairman, to put some of these ideas into concrete form with a product you probably all know, consider the Mazda Miata, a remarkably successful little medium-priced convertible roadster that sold at a substantial premium over the sticker price when so many other manufacturers were offering rebates—and, I am pleased to say, designed right here in the U.S.A.

What made the Miata possible was, as Kim Clark of Harvard reminds us, that Mazda had in place an advanced manufacturing capacity that enabled it to make a profit with a run of just 40,000 cars using mixed-model assembly procedures, highly automated and flexible welding processes, and sophisticated short-cycle stamping.

And the Miata example also reminds us that the ability to serve customer needs individually encourages the sales side to probe the market more deeply—that is, to take advantage of highly profitable niche markets. This, of course, illustrates not just the importance of advanced manufacturing, but what a firm can accomplish when its engineering, manufacturing and marketing functions are properly integrated.

Nevertheless, Mr. Chairman, it is by no means clear that these advantages are well-understood by all the firms that could take advantage of what these systems have to offer.

Let me make it clear at the outset that I am not suggesting that our manufacturing sector is about to go down the tubes. Recent statistics demonstrate that manufacturing productivity was up a solid 3 percent in 1990, following a similar rise in 1989. Despite recessionary fears, the decline in manufacturing productivity in the last quarter of 1990 was only 1.6 percent, due largely to lower inventories and unit labor costs.

Moreover, some of our larger companies are becoming aware of the advantages of flexible manufacturing systems and a number of large companies have invested in them. However, optimism must be tempered with caution. U.S. companies do purchase them, but they turn out only about 25 different products on each piece of equipment, about one-tenth of what others, such as the Japanese, do.

Further, large companies are highly dependent on the Nation's 350,000 small and medium sized manufacturers for top quality machinery and components. This U.S. sector shows much less interest in advanced systems than its foreign competitors, such as in Japan, where fully half the systems are purchased by smaller companies.

I do not believe we are likely to see a dramatic change any time soon. Gross real investment in manufacturing was flat during most of the 1980s; most capital investment was in the nonmanufacturing sector. Recent Census Bureau studies suggest

that real capital spending in the manufacturing sector is likely to increase only about .7 percent this year.

I am concerned about the long-run implications if smaller firms continue to show little interest in investing in new manufacturing technology. U.S. companies could turn to foreign firms with more current technology and skills, with the result being less growth and employment than if domestic sources were providing the components. U.S. assemblers could be at a competitive disadvantage if they are dependent on foreign outsourcing because of higher inventory and related costs. There are important advantages to colocation of assemblers and suppliers that would be lost.

And there is still another loss, less tangible but perhaps even more significant in terms of our long term interests. Technology transfer is a two-way street. Smaller firms learn from the larger ones and vice versa. As small firms master new technology it is to be expected that their own creativity will increase and be passed on to the larger firms.

The CEO of Proctor & Gamble recently recounted a story about how its plant managers couldn't figure out how to feed elastic into its disposable diaper production lines at high speeds without it becoming tangled. It called in its elastic supplier who took one look and realized the problem was similar to one that the supplier had already solved in producing wound elastic for the centers of golf balls. According to the CEO, the supplier had P&G's plastic diaper lines running at high efficiencies within minutes.

In other words, the innovative potential of our manufacturing sector as a whole—that is, its ability to create commercially viable products and processes—depends in large measure on the health, vibrancy and creativity of our small and medium sized manufacturers.

That brings me to the second question I identified earlier: If the stakes are indeed so high, why are we seeing so little progress?

To some degree, we have been a victim of our own postwar success. Given the devastation of so many other nations in World War II, the United States turned inward and reaped enormous success by mass-producing undifferentiated goods for the domestic market, by ignoring external scientific and technological developments, and by often training workers to do narrow, specialized jobs rather than building a pool of multiskilled workers adept at working with new and changing technologies in the workplace.

To expect a firm to shift from traditional modes of manufacturing to "lean production" is, as some observers have put it, much like expecting a family to upgrade to a helicopter rather than simply buying a newer car every so often. The helicopter opens up possibilities you never dreamed possible and not many people have the vision to appreciate it. But by the same token, it represents an enormous investment and unless you are fully prepared to take advantage of it, you may well have wasted your money and created real problems for yourself.

That requires a lot. I have attached a chart which describes the differences between traditional manufacturing and lean production. As you can see, you are talking about changes in how a company sees itself, its product, its customers, how it is organized, its culture, its approach to quality, how it treats its workers, how it is laid out—everything!

It is asking a lot of any firm to change itself completely almost overnight. It is expecting an almost superhuman exertion from smaller firms, many of which I believe do not truly appreciate that they are competing in global markets; lack adequate information about off-the-shelf systems that are available and what they can do; lack the computer literacy that is an integral part of programmable automation; or do not understand the new management methods and philosophies that are required.

And compounding this, some of the key determinants of competitiveness—quality, life cycle costs, just-in-time-delivery, and the ability to change product rapidly—are intangibles that cannot easily be quantified and that are largely ignored by traditional accounting practices.

For example, in an earlier time, most costs of production were for labor and materials—variable costs—and measurement systems could readily be devised. Today, however, labor is a small fraction of total costs and indirect costs, such as depreciation, materials control, quality assurance, maintenance and process engineering, and software development, can exceed labor by a factor of anywhere from 5 to 10.

What this means is that under traditional methods, companies spend a disproportionate amount of their time measuring costs that account for a relatively small portion of the total, make decisions thereon that may ultimately be unwise (for example, decisions on whether to contract out or to make something in-house), and—

probably worst of all—management attention is distracted from more pressing strategic issues.

In sum, if accounting is to serve its intended purpose as a decisionmaking tool, we have to make certain its conventions and principles reflect the current production environment. If we start out with firms that, through lack of information, cultural bias, or natural resistance to change, are ill-disposed toward lean production, and compound it with decisionmaking tools that exhibit a similar bias, then we have a true prescription for disaster.

Is the problem on underinvestment essentially a problem for the civilian sector? Yes. Does DOD have any stake in the outcome? Absolutely. And because DOD has such an enormous impact on the economy, whether it wants to or not, and because of the synergies that can result from their cooperation, DOC and DOD are increasingly aware of their common stake in a manufacturing renaissance.

First, like many agencies, Defense faces downward pressure on its budget. That means fewer brand new systems and greater emphasis on upgrading existing military systems in the field with advanced technology. Upgrades will often depend on overcoming manufacturing obstacles—for example, DARPA's pilot production lines aimed at overcoming manufacturing roadblocks to the production of gallium arsenide microelectronic circuits in requisite quality is important for upgrading systems that now rely on less efficient silicon-based semiconductors.

In addition to upgrading existing systems, advanced manufacturing is likely to become an increasingly important tool by which DOD will be able to reduce manufacturing costs, such as by greater use of computers in design, production scheduling, ordering, and inventory control; and using automated ordering systems to reduce acquisition costs.

And budget pressure will also mean greater pressure on DOD to insist that quality be designed into a product and that the manufacturing process be designed to produce defect-free products, on time, and within cost. Defense suppliers throughout the supply network, just like suppliers to large makers of consumer goods, will learn that it will no longer be cost enough to rely on inspection and subsequent process adjustments.

But the issue is not just one of controlling costs. There are also serious national security imperatives. I do not think it is practical to expect DOD to buy enough to keep all its suppliers in business. If its smaller and medium-sized manufacturers do not modernize and develop the capacity to serve both the defense and civilian markets, they will not survive and DOD could become increasingly dependent on foreign suppliers. Similarly, if they survive but cannot meet unanticipated surges in demand, such as in times of national emergency, our dependence on foreign suppliers could similarly increase.

As successful as Desert Storm was, we should note that some effort had to be undertaken by the U.S. Government to ensure a steady supply from foreign sources of crucial materials, such as special battery packs, transistors, and parts for video display terminals.

And that brings me to the fourth question: So what is the Technology Administration at Commerce doing about the need for increased use of advanced manufacturing tools by U.S. industry? In sum, we are attempting to address the problem from both the "business" and "technology" perspectives. The two activities are intimately related: it does us little good to promote the advancement of manufacturing technology unless we address the root causes of underinvestment, or to encourage investment if the technology isn't there.

From the "business" perspective, my fundamental point is that the key to adoption and effective use of automated manufacturing is management's understanding of its true business impact and its ability to justify the investment. The Technology Administration is directly attacking both fronts.

First, it has developed and championed the concept of shared flexible computer-integrated manufacturing (FCIM) facilities. This is essentially a manufacturing service center which has state-of-the-art/off-the-shelf flexible manufacturing systems that lease manufacturing time to small firms. We serve as a catalyst to their formation but they are financed mainly by the private sector and to some degree by State governments. Federal agencies also contribute when the center can serve their mission requirements.

Through this process, small firms can provide a much wider range of products, milk niche markets, respond to sudden changes in demand, and achieve unprecedented levels of quality and consistency—and do so with no initial investment in plant and equipment. Equally important, to the extent FCIM facilities can serve as "teaching factories," smaller firms can see how these systems operate and learn to use them. And we are not just talking about educating workers and plant managers;

we are also talking about educating chief executive officers, chief financial officers, and marketing managers.

In a very real sense, FCIM's can be seen as direct descendants of the time-sharing concept through which large computer firms leased time on their mainframes to manufacturing and service companies, provided training, and eventually spawned a sophisticated information processing market.

Today 6 FCIM centers are running with 16 more in the planning stage. We hope to have as many as 200 in operation by the end of the century, with some tied to educational institutions, some administered by nonprofit organizations, some run on a for-profit basis, some hybrid in nature. Many of them will be tied to regional economic development goals, such as the Robert Byrd Center at Huntington, West Virginia, which is an integral part of the State's strategy for making the transition from a mining to a manufacturing/software development economy.

And a number will directly support DOD interests. For example, the Rock Island Arsenal is an active sponsor of the Manufacturing Technology Consortium in Western Illinois. As the U.S. heads into a peacetime economy, Rock Island will be diversifying its mission to include training and development. In cooperation with the Consortium, it will be broadening its operations to include a "teaching factory" capability. The Army Aviation Command will be looking to the DemMaTech Center at the University of Missouri as a source of no longer-available critical spare parts.

The FCIM's have truly been a laboratory through which we have learned much, not just about manufacturing problems per se, but about the financing problems that these companies face. That brings me to the second aspect of the "business" front. The Technology Administration, along with the Treasury Department, has been working with the financial community, businesses, pension funds and related organizations to help give us all a better understanding of the root causes of underinvestment in technology, such as accounting standards that may make it harder for firms to take the long view.

We are also working with the private sector to catalyze U.S. industry in response to a major advanced manufacturing initiative from Japan. I have discussed at some length the difficulties of encouraging U.S. firms to adapt to the more fundamental aspects of lean production. Well, Mr. Chairman, our Japanese competitors are already looking at its highest aspect, Intelligent Manufacturing, which, through the use of computer software reprogramming, holds the promise of continually adjusting production to meet changing needs.

This is one area where the Japanese feel the United States has much to offer, given our skills in software and systems integration. They have made proposals for collaboration to U.S. industry. Our Office of Assistant Secretary, which has broad Departmental responsibilities for international S&T activities, is working with industry to ensure that such collaboration does not expose our leading edge technologies to our competitors without an adequate return.

Turning to our technological, as opposed to our business, front, the Technology Administration's principal tools are the Malcolm Baldrige National Quality Award, our Automated Manufacturing Research Facility (AMRF) and the new industrial outreach programs established by the Omnibus Trade and Competitiveness Act of 1988.

Through the Baldrige Award, we strive to promote quality awareness, to recognize quality achievements of U.S. companies, and to publicize successful quality strategies.

In my view, the program has succeeded not only in these objectives, but in far more subtle ways. Many firms, considering themselves to be "world class" have, upon examining the criteria, concluded that they are not. Rather than condemn the criteria, they have adopted the qualifications as a road map to future excellence. A number of major U.S. companies, including several Baldrige Award winners, are urging their suppliers to use the Award guidelines as a way to upgrade quality. This involves thousands of small and medium-sized businesses.

I was delighted to learn recently that the Defense Department's Defense Contract Management Command has taken a leaf from the Baldrige Award and is planning to designate certain facilities as "exemplary" facilities for consistently producing quality products. The goal is to encourage its contractors to "build quality in" and get away from post-production inspection and the costly post-inspection audits, regulations and red tape.

While all of NIST's laboratory programs contribute in one way or another to U.S. competitiveness, our Automated Manufacturing Research Facility (AMRF) has special relevance. The AMRF is a major laboratory for technical work related to the interfaces and standards of the next generation of computer-automated manufacturing. It is unique in the opportunities it provides for studies of an integrated system

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of significant size and its work is of particular interest to industry, universities and other agencies.

Through the AMRF, we were able to demonstrate a technique it developed for improving the accuracy of machine tools that has enabled U.S. manufacturers to penetrate the highly competitive markets for specialized measuring machine tools in both Europe and Japan. Recognizing that post-process inspection is inadequate to meet modern global competition, we pioneered a computer-controlled, in-process method of error correction that is now being adapted to some of the most demanding products in the world today, such as Level One Fasteners for nuclear submarines.

Based on the work of the AMRF, NIST scientists and engineers were able to develop and disseminate an architecture for the real time control of robots, machine tools, measuring machines, workstations and manufacturing cells. While this work directly impacts efforts to automate in the manufacturing, construction and mining industries, space station telerobotics, and undersea and planetary exploration, it is also important to DOD for the development of unmanned vehicles for air, land, and undersea weapons systems.

We are also working with DOD in the development of the Product Data Exchange Standards, known as PDES/STEP. The standard is intended to provide a way for manufacturers to express all useful information about a product's dimensions, materials, performance characteristics, and other data in a digital form that would be accessible to a manufacturer's suppliers, contractors and other support groups. Through this, we hope to get at one of U.S. manufacturing's biggest problems: the failure to integrate product design, manufacture, and marketing.

What we learn in-house directly supports our ability to transfer leading edge manufacturing technologies and techniques to the private sector through programs such as the Manufacturing Technologies Centers. This program was established by the 1988 legislation. We soon expect to have six regionally-based centers in operation serving approximately 2,400 small and medium sized manufacturing companies.

The personnel at our MTC's introduce companies to manufacturing technologies and techniques that can improve quality and efficiency. They work closely with community and technical colleges to identify and serve smaller firms, and provide work force training to accompany the introduction of technological advances.

The 1988 legislation also established an Advanced Technology Program which is aimed at assisting business in promoting the commercialization of precompetitive generic technologies, including advanced manufacturing technology. Just last month, the Department announced the 1991 winners, which included awards for several manufacturing-related industrial consortia—for example, projects relating to advanced manufacturing technology for low-cost flat panel displays, x-ray lithography, compensation techniques for enhancing machine tool accuracy, and fabrication techniques for advanced thallium superconductor technology.

And that brings me to my concluding remarks, what are the implications for agencies such as the Technology Administration and the Defense Department? Where should they concentrate their energies?

First, Mr. Chairman, I believe we must recognize that the advent of advanced manufacturing has enormous implications for mass production industries, such as its ability to enable them to meet surge needs and to convert to defense production; for continuous process industries, such as facilitating the manufacture of high value specialty chemicals and pharmaceuticals as opposed to bulk chemicals; and manufacturers of complex, high value discrete parts. All of them are going to have to adjust to wrenching change.

Second, we must recognize that change won't happen overnight. Reducing capital costs can provide important incentives; reducing hostile takeover threats may make it easier for firms to take a longer view. However, as my comments have indicated, we must recognize that we are dealing with fundamental cultural biases reinforced by conventional financial operations.

Third, we cannot place an unfair burden on the Department of Defense and complicate its efforts to set meaningful national defense priorities. Some advocate that DOD must strive to maintain a healthy set of technology options in light of military uncertainty and, as such, should focus on long term investments to sustain the Nation's overall technology base. Others advocate emphasis on dual use technology to strengthen the industrial base. Others say DOD should leave dual use technology to the private sector and focus on technology of particularly military significance that would not otherwise be available.

Given budget pressures it does not seem fair to look to DOD to fund activities we deem desirable for the same reason Willy Sutton robbed banks: "Because that's

where the money is." The money won't be there. The ultimate responsibility modernization lies with the civilian sector itself. But if resources are properly oriented, there can be substantial commercial benefits.

Recent events in the Middle East provide some guidance as to why this should be so. That episode demonstrated clearly that military strength is not solely a function of how many soldiers you have, or how many tanks or airplanes. It increasingly depends on such factors as whether you have the quality equipment that can identify and destroy enemy personnel, materiel and weapons; whether you can block the enemy's communications while preventing them from jamming yours; whether you can properly use computers to assimilate and manage enormous amounts of battlefield information.

What I would conclude from this in terms of the issues before us today is that our national security should increasingly depend on manufacturing excellence in certain key identifiable industries, such as semiconductor chips, computer networks, and precision robotics. And, if that's the case, then the line between military and civilian markets will grow increasingly dim. And so will the line between purely military and purely civilian research.

Following from this, I would expect there to be greater commercial bang from the defense buck and vice versa. That's good. However, since you asked me to comment on "issues associated with sharing our technology advances with foreign nations," let me add that it also means that efforts to "control" access to the results of research as the two areas become increasingly intertwined will be harder. Those who cannot tolerate any restrictions on access to R&D and those who see any sharing as inimical to our national security interests will have to reach some new accommodations.

Commerce has a clear role to play. It can bring the different players together, as we are doing in our Financing Roundtables, to develop consensus on the root causes of underinvestment in advanced technology and to develop appropriate strategies. It can itself further the knowledge base for advanced manufacturing technology where private sector incentives are weak, and transfer that knowledge to the private sector, as we are doing in our NIST programs. And we can facilitate the continued development of flexible manufacturing systems for our smaller and medium-sized manufacturers, as we are doing through our Technology Policy operation. By properly focusing our energies, we can do much.

Thank you, Mr. Chairman, that completes my statement. I will be pleased to answer your questions.

ELEMENT	TRADITIONAL MANUFACTURING	LEAN PRODUCTION
Marketing/Company Identity	Sell What Company Makes	Make What Customers Want
	Narrow Market Concept	Broad Market Concept
Outlook	Short-Term	Long-Term
Product Portfolio	Narrow/Uniform Products	Diversified/Variety of Products/Variations
Manufacturing System	Inflexible	Flexible
Equipment Layout	Grouped by Function	Cells Make Whole Product/Subassembly
Lot Sizes	Large	Small to One
Work Flow	Large Batches Move From Functional Group to the Next	Small/Single Lot Sizes Flow Continuously Through Cell
Manufacturing Cycle Time	Long	Short
Quality Approach	Inspection	Quality Designed Into Product Process Designed to Produce Quality
	Process Adjustment After Defects Identified	
Innovation System	Linear	Concurrent
	Relay Race Passes Innovation From One Group of Specialists to Another	Multidiscipline Product Development Team
Rate of Innovation	Infrequent	Perpetual
Inventories	Substantial	Little/None
Workplace Organization	Hierarchy	Flat
	Functional/Specialized Departments	Networks of Multi/Cross Functional Teams
Job Design	Narrow	Broad
	Specialization	Multi/Cross Skilled
	Repetitive/Simplified/ Standardized (Idiot-Proof)	Multiple Responsibilities
Workforce Management	Command/Control Systems	Self-Management
Approach to Change	Avoid/Resist	Embrace
	Change Infrequent	Change Continuous
Communications/Decision-Making Responsibility	Chain of Command	Widely Diffused
Direction	Standard Operating Procedures	Procedures Under Constant Change
Producer-Supplier Relationships	Arms-Length	Close
	Adversarial	Cooperative

Senator BINGAMAN. Thank you very much.

You indicated you are trying to be a catalyst for the establishment of these flexible computer integrated manufacturing facilities and you hope to have 200 of those by the year 2000. How do those differ from the five manufacturing technology centers which you indicated you have?

Dr. WHITE. The manufacturing technology centers are jointly funded. We have put in approximately $2 million and then there is matching funding from State or local sources of a comparable amount. And those centers serve basically as brokers for manufacturing technology. They take technology that, perhaps, is developed at NIST, in universities, or wherever, and distribute it and make it available to small business enterprises in the vicinity of those manufacturing technology centers.

One example that I can cite relates to the center we have at RPI in Troy, NY, where a small plastics firm in the nearby area came to the center, learned about CAD/CAM technology, purchased a CAD/CAM system and is now completely automated in terms of its products.

The flexible computer-integrated manufacturing centers, or the FCIM's as we call them, are centers which we put together or helped put together based on funding that often comes from State or local sources. And what that does is it provides the capital for purchasing modern equipment which is then leased or made available on, perhaps, a trial basis to small manufacturers in the area.

Senator BINGAMAN. Did you put any money into those centers?

Dr. WHITE. We have not. A good example of one of those centers is at Hagerstown Community College where they have established a manufacturing cell supported by money from the State of Maryland and the Appalachian region. And they used that cell to give local manufacturers some hands-on experience so that they can then go forward and buy equipment like that.

Senator BINGAMAN. My concern is that I am not exactly sure what the Department of Commerce adds to that. I understand Maryland is doing that. In fact, in New Mexico, we have a manufacturing productivity improvement center which has begun to have some successes and we hope we can continue to fund at the State level. What does the Department of Commerce add to that, if you do not add money?

Dr. WHITE. I think what we bring to that is the integration of those centers, what we bring is an experience from having set them up so we can help new centers become established, introduce them to what it is that they must do to get these centers going, and then coordinating a network of those centers to share their experiences. So basically, we are the catalysts.

Senator BINGAMAN. I see. Congress directed you to pursue this through NIST in the 1988 Trade and Technology Act. It was a program called the State Technology Extension Program. My concern is, as far as I know, the administration has asked for no money for that program. What is your position on it? Why is there no request for any funding in your budget request?

Dr. WHITE. This year we did fund nine of those extension efforts. This was a new program that was started at the same time as the manufacturing technology centers, the MTC's. Our experience was

that the MTC's were, in fact, doing the job that that extension program had envisioned, and doing it better.

Senator BINGAMAN. The manufacturing technology centers were?

Dr. WHITE. Yes.

Senator BINGAMAN. Do you believe the five manufacturing technology centers that you have established are accomplishing this purpose?

Dr. WHITE. That is correct.

Senator BINGAMAN. Is it your intent to put funds into this other State Technology Extension Program in the future?

Dr. WHITE. That was our feeling.

Senator BINGAMAN. I see.

Dr. WHITE. That is, our feeling was that we could accomplish that purpose better by working it through the manufacturing technology centers.

Senator BINGAMAN. Is it also your thought that you would like to see 200 of these flexible computer integrated manufacturing facilities by the year 2000? Is it your intent to request money from Congress in your budget to assist with funding of those? Is it your thought that you will continue to play this coordinating function?

Dr. WHITE. We have not asked for anything for them in the 1992 budget. Beyond that, if these grow and are successful, I do not know what we will do.

Senator BINGAMAN. What is the level of this year's funding that the Department of Commerce is putting into manufacturing?

Dr. WHITE. That is, into total manufacturing, we have about $10 million in the manufacturing technology centers. We have another several million, I think, in the extension programs, and the NIST automated manufacturing research effort itself, is a relatively large, my guess, would be $20 or $30 million, but part of that is paid for by other agencies. We receive, for example, aid for the PDES effort, funding from Mr. McMillan's organization for that.

Senator BINGAMAN. You indicated that U.S. industry, at least in your view, has fallen behind some of the international competition in modernizing its manufacturing capability. Is that problem worse in the defense sector or in the nondefense sector?

Dr. WHITE. I would say that it probably runs across both of those. I think that in the sense that the defense sector has to rely on multiple tiers of smaller and smaller suppliers, you will find, as you go down into those multiple tiers, that those small and medium size companies are not, in fact, taking advantage of modern technology for either supporting their defense purposes or commercial markets.

Senator BINGAMAN. So the problem is all across.

Dr. WHITE. I think it runs across our manufacturing sector.

Senator BINGAMAN. My time is expired. Senator Coats.

Senator COATS. Dr. White, I really have one question and maybe this will spawn some other questions. But in your statement, you talked about the need to change the culture in the manufacturing sector, rather than focusing on more specific isolated issues, such as cost of capital. And I am wondering if you could elaborate for us what you would recommend as criteria that this committee use to make decisions on funding to bring about, if possible, necessary cultural changes in the sectors that support the defense industrial

base. What kind of things ought we to be looking at and is there anything that we can legislatively do or encourage through our legislation, to bring about some of those changes?

Dr. WHITE. I do not know about legislative changes, but I think one of the things that you could certainly do, perhaps through hearings, is bring some kind of focus to this issue of lean production. I mean, if you look at that chart that was in my testimony, you will find that in every aspect of manufacturing, of operating a company, in fact, there is an almost orthogonal relationship between traditional manufacturing and lean production. It is absolutely critical that we recognize that difference and try to promote that change in culture.

And so I think that hearings that focus on lean production and what it means, and that will address and sort out what the barriers are to making these cultural changes and to introducing the new manufacturing technologies would be very useful.

Senator COATS. Are not market forces really the only real impetus toward bringing about, forcing these changes or bring about these changes?

Dr. WHITE. I think that they play a very important role in it, but I think that making people aware of what is there will only accelerate that process.

Senator COATS. And in addition to holding hearings, which I would think might have a very limited application in terms of spreading the words and what these cultural changes need to be, is there anything else you can suggest relative to tying some of these appropriations or grants to certain specific required changes within those industries?

Dr. WHITE. I think that one of the elements that is part of this cultural change relates to quality. And I think that tying your activities to the efforts that would promote this quality revolution that we have underway, as evidenced by this enormous participation in the Baldrige Quality Program, would be helpful.

Senator COATS. What is that participation?

Dr. WHITE. The Baldrige, I guess you are familiar with——

Senator COATS. I am familiar with the award. You said the enormous participation and I——

Dr. WHITE. Last year, I think we circulated something of the order of 12,000 application forms. This year, it went up to 180,000. So there is an enormous awareness of——

Senator COATS. You received that many applications?

Dr. WHITE. No. The actual number of companies that have, in fact, applied is much smaller. And I think, in fact, this last year it was something of the order of perhaps 100.

Senator COATS. Out of the 12,000 circulated?

Dr. WHITE. Out of the 180,000 applications that were sent out.

Senator COATS. You sent out 180,000 and 100 applied?

Dr. WHITE. Yes. What that tells you, I think, is that companies are getting a great deal of benefit out of working through the guidelines that we provide. And in fact, the people who win the Baldrige Award will, in fact, tell you that it is not winning the award that is the benefit but, rather going through the process of bench marking themselves against the criteria that we have established.

Senator COATS. Well, I would not classify 100 out of 180,000 as enormous participation. I would classify it as enormous interest on the part of Commerce in making companies aware of the award. But it does not seem to me all that significant a response out 180,000 applications going out.

Dr. WHITE. I think the request for 180,000, to me, is an indication of the enormous—

Senator COATS. Oh, I misunderstood you. You had a request for 180,000?

Dr. WHITE. Yes.

Senator COATS. I am sorry. I thought you just arbitrarily——

Dr. WHITE. Oh, no. No.

Senator COATS. All right. So the increase in requests went from 12 to 100—all right. That is significant. And the program is new and you see some publicity. Now I think even companies are using it in their advertising.

Dr. WHITE. That is correct.

Senator COATS. It is a mark of distinction. All right. Thank you, Dr. White.

Senator BINGAMAN. Senator Smith.

Senator SMITH. Thank you, Mr. Chairman. Good morning, Dr. White.

Dr. White, I am interested in a statement that you have on page 17 of your statement in which you say, "Those who cannot tolerate any restrictions on access to R&D and those who see any sharing an inimical to our national security interest will have to reach some new accommodation." Would you expound on that a little bit? That is a very, very difficult dilemma as you well know.

The type of research and development that was done to provide the weapons systems that we had in this last war was extremely successful. Yet, if that kind of a technology is allowed to emanate out through the world community, then we are basically putting ourselves in a defensive position again in the sense that we have got to go back and reinvent the wheel and try to move out ahead, and may, in fact, lose ground. What is this accommodation? I mean, give me some parameters to define that type of accommodation.

Dr. WHITE. I do not know the answer to that. The purpose of that statement was simply to point out that what I see happening is that all the advances in technology, and particularly in manufacturing, are coming in the private sector. I think advances in displays are appearing first. The most advanced displays are in wrist watches. The most advanced storage devices are in PC's.

And so what I am saying is that for military systems, you are going to, in the future, come to rely more and more on the technology in the manufacturing practices that exist out there in the private sector. And I think that is going to make it increasingly difficult to develop, if you like, proprietary kinds of technologies for security purposes. And I am just saying that we are going to have to face that dilemma. I do not know the answer to it.

Senator SMITH. I think part of the problem, as you well know, is the dual use, especially in the area of computer technology in both domestic use as well as military use. For example, in my State, as in most States, there are many computer businesses. And we hear

these arguments a lot. "Do not place so many restrictions on us. We need to be able to compete," et cetera, et cetera.

But I am concerned about what accommodation we have to make and I wish that you could expand on it a little bit more. I understand the dilemma. But it is going to be an issue, I think. One that needs to be faced squarely in the next few years.

That is all the questions I have, Mr. Chairman. Thank you.

Senator BINGAMAN. Let me ask a few other questions, if I could, Dr. White. In 1916, we passed the so-called Smith-Lever Act to establish the Agriculture Extension Service, which has worked very well. In my State, I know we have an agriculture extension office, which is, I guess called, a cooperative office. I think in Texas they call them agriculture extension offices. In New Mexico they call them agriculture cooperative offices or something to that effect.

At any rate, they are very effective. For example, if you want to plant a field of chili, or raise a pecan tree, or anything you want to do related to agriculture, there is modern and efficient expertise available to assist you in doing that. Why do we not have a similar program for folks in manufacturing, if we have 350,000 people trying to manufacture, as you say, and if they are behind the curve as far as implementing changes in their processes?

Dr. WHITE. Mr. Chairman, I agree with you. I think the agriculture extension program is probably the most effective program of its kind ever. And I tend to want to think of our manufacturing technology centers as doing exactly the same thing. Now, although we have only five, they are regional centers and they are reaching out to some subset of those 350,000 manufacturing enterprises that we have. The one that we have just formed in Michigan, for example, has already liked up with 800 sheet metal workers in that area that support the automotive industry.

And so, you are absolutely right. And I think that what we are trying to do through the MTC's and the FCIM's, is really, in some sense, to approximate what was so successful in the agricultural area.

Senator BINGAMAN. Let me ask you a few questions about the cooperation between your Department and Department of Defense in particular. We passed some legislation this last year, which I want to ask Mr. McMillan about, also. This legislation provides that the Secretary of Defense, in coordination with the Secretary of Commerce and the Secretary of Energy, shall develop and implement a national defense manufacturing technology plan.

It then discusses the link between manufacturing technology programs and the industrial preparedness programs that exists. In addition, it talks about promoting the improvement of sub-tier defense industry through use of manufacturing extension programs. It also states manufacturing extension programs so used shall include programs carried out by the Secretary of Commerce. What has been the extent of your involvement in that plan?

Dr. WHITE. We have just begun to work with Mr. McMillan and his people on this. We have several people from my organization who are part of his working groups. And we have established a cooperative working arrangement.

Senator BINGAMAN. A lot of things we have done in the Federal Government over the years, particularly during the Cold War

period, have been done in two fairly discreet and tightly separated departments, defense versus nondefense. We have a facility in our State that Mr. McMillan is very familiar with, called the WIPP project, which is limited to receipt of defense produced low-level and transuranic waste. So we have one facility for defense-related nuclear waste and one of the other facilities, at least, for nondefense. That is just an example of how we have struggled to keep defense and nondefense separate.

Is there any reason to keep those same tight compartments in this area? Does it make sense for the Defense Department to have a manufacturing modernization program which works with people that sell to the Defense Department and the Department of Commerce to have a manufacturing modernization or extension program which works with people who presumably do something else?

Dr. WHITE. I do not think so. And I think that you might be interested to know that we have underway, through the FCCSET (Federal Coordinating Committee for Science, Engineering and Technology) process, an interagency inventory of all the manufacturing R&D activities that are underway in the Federal Government. It turns out that the Federal Government spends over $1.2 billion in what they call manufacturing R&D.

And what we are hoping to do is to look at how that is being invested and see whether or not there are ways in which we can get the private sector involved in finding a better way to utilize that investment.

Senator BINGAMAN. That is R&D and not manufacturing extension as such, as I understand it. Are you making that distinction there?

Dr. WHITE. I do not know how they categorize some of those areas. I think that in some areas, they may fall into the development area. We are just going to have to look at that.

Senator BINGAMAN. One other area I wanted to question you about is this IMS proposal, the Intelligent Manufacturing Systems proposal that the Japanese have made to the United States and to Europe. Can you tell me the status of that and what you think an appropriate U.S. response should be to that proposal?

Dr. WHITE. I think you are probably well aware of the fact that Commerce has taken the lead in bringing together the private sector to try to develop some kind of a response to Japan's proposal that we do some kind of cooperative R&D, if you like, or technology development in the area of manufacturing.

What we have done recently is, to put together terms of reference that will form the basis for a negotiation with Japan and with the European counterparts. The terms of reference include a structure that consists of various committees—administrative committees, committees to worry about how to choose the technologies that we might want to work on—and also a working group on intellectual property rights and their protection.

Those terms of reference have gone through the interagency process now. They were developed cooperatively with the private sector through many consultations with private industry. And those terms of reference have now been forwarded on to the Japanese and to the Europeans for their opinion.

Those terms of reference call for a feasibility study to be made—basically a trial experiment, if you like—to try to identify, first of all, some area where we can do something cooperatively. Then to engage in that over the period of approximately 18 months, at the end of which time, we would review it and see whether, in fact, we can cooperate with them in this area.

If we find, in fact, that we cannot, that there is some still imbalance in the benefits from such an arrangement, then we would take action at that point.

Senator BINGAMAN. Let me ask one follow-up question. Is the Defense Department involved with you in this effort or should they be?

Dr. WHITE. Yes, they are. And in fact, we have been having ongoing dialogue with Mr. McMillan and his people as to what role they will play in IMS.

Senator BINGAMAN. How about the Department of Energy?

Dr. WHITE. Yes. The Department of Energy takes part in our deliberations as well.

Senator BINGAMAN. Okay. My time is up. Senator Coats, did you have any questions? Senator Smith?

I know you have other pressing obligations. Thank you very much for coming today and testifying. We appreciate it.

Senator BINGAMAN. Mr. McMillan, why do you not go right ahead. We are very appreciative of you being here and talking to us about this subject.

STATEMENT OF HON. COLIN McMILLAN, ASSISTANT SECRETARY FOR DEFENSE FOR PRODUCTION AND LOGISTICS, DEPARTMENT OF DEFENSE; ACCOMPANIED BY NIC TORELLI, DEPUTY ASSISTANT SECRETARY FOR PRODUCTION RESOURCES, DEPARTMENT OF DEFENSE, AND CHUCK KIMZEY, CHAIRMAN, MANUFACTURING TECHNOLOGY TASK FORCE

Mr. MCMILLAN. Mr. Chairman, I am delighted to be here today and have the opportunity to talk about manufacturing technology. I have prepared a written statement which I will submit for the record, and I would like to summarize that statement and leave the remainder of the time for questions.

Senator BINGAMAN. That is fine.

Mr. MCMILLAN. I am accompanied today by Mr. Nic Torelli, Deputy Assistant Secretary for Production Resources, and Chuck Kimzey, Chairman of the Manufacturing Technology Task Force. They may be able to help me answer some of your questions.

Your letter requested that we provide the status and plans for the Department's efforts to comply with section 823 of the 1991 Defense Authorization Act. You specifically asked for a description of our activities toward the development of the National Defense Manufacturing Technology Plan, two, the promotion of research disciplines related to manufacturing technology, and three, the improvement of the sub-tier defense industry through the use of manufacturing extension services. You also asked about what has been the initiative for the new $50 million manufacturing technology funding line. We are well on our way to meeting the letter and spirit of that legislation.

Let me address the first point of your inquiry, the development of the National Defense Manufacturing Technology Plan, the NDMTP. The plan is being developed as a broad DOD effort and will not be exclusively the effort of OSD. Acting Under Secretary of Defense for Acquisition, Don Yockey, chartered a task force, directing participation in the development of the plan from all services, DDR&E, DARPA, SDI office, and the Defense Logistics Agency.

The legislation called for coordination of our efforts with other Federal agencies, particularly the Departments of Energy and Commerce involved in manufacturing technology. To ensure that this is accomplished in a meaningful way, we have asked those agencies to join our task force. We carried the suggestion further by including the National Science Foundation and NASA as members. The cooperation and support we are getting internally and from other agencies is excellent. We are already finding opportunities where cooperation will serve manufacturing interests.

The task force is broken down into subcommittees—two on the strategic direction for manufacturing technology, one on technology transfer, and one on management. The strategic technology or technical direction of the program will be developed from data we are collecting in three categories: (1) known barriers to effective production; (2) opportunities to reduce cost to prioritize manufacturing operations; and (3) a view into the most distant future of manufacturing systems. Data from the first two categories is coming from a review of approximately 30 major systems that will account for a majority of the Department's procurement expenditures, at least as we can project today for 1994 and beyond.

We are trying to understand the manufacturing activities that have consumed the largest portion of the DOD's resources. This type of data has not been available before, so we are plowing new ground. This is being done by all the services, so that we, for the first time, can accumulate estimates of manufacturing operations such as machining, joining, or assembling across the entire DOD to assist in setting priorities.

In addition to the weapon system's specific data, we are utilizing expert opinions to develop a longer-term vision to serve as a foundation for setting specific goals. Too many times we are consumed with solving today's problems, leaving tomorrow's for later. A lack of vision into the manufacturing system of the 21st century was sure to keep us behind the eight-ball, continually running to catch up rather than anticipating, planning, and executing manufacturing technology in time for insertion in tomorrow's defense production systems.

We are seeking out the foremost experts in manufacturing in this country as well as gathering data from foreign sources. A possibility may even be international cooperation, where the Department's goals might be achieved sooner or at less cost than by an independent attack on the problem.

The task force will have the responsibility to synthesize the more subjective data on vision with weapon-specific information to develop a technical focus. We expect this process to set the foundation, as was suggested in report language, for a coordinated DOD manufacturing technology program, as opposed to several independent service programs.

One outcome I can predict is an improved linkage between this program and the Research and Development (R&D) community. We are taking steps to assure that DOD efforts in production technology will be receiving more effort in related process technology. In other words, we are putting concurrent engineering in practice.

Along with activities to determine the technical direction, the task force is reviewing the way in which the program is managed. The task force will make recommendations on the most effective way we should be organized to achieve the technical goals that we define. The DOD instruction that governs the program is already being modified.

The final task force effort is on technology transfer, which is of particular interest to this committee. The legislation specified that we conduct an analysis of the extension service's ability to transfer manufacturing technologies to defense sub-tier contractors.

We have expanded this task into a broader question. How can the MANTECH program improve this technology transfer through any means? To assure that we bring new thinking into this area, we have asked the Department of Energy to chair this task force. This committee is aware of the innovative approach taken by DOE in the transfer of lab technology. We want to make sure that DOD can take advantage of the DOE experience.

As you know, we worked out an arrangement for an interim release of funds to (1) take advantage of service knowledge and planning, (2) to get an early start on known high priority issues, and (3) give the National Defense Manufacturing Technology Plan a kick-start now rather than waiting until the end of the fiscal year.

The interim release is fully described in my written testimony, but, to summarize, we conducted a DOD-wide technical competition that was subjected to review within the Department, by other Federal agencies, and by industry. What emerged from this process was a fairly strong consensus on some areas and an acknowledgement that we need to do work in other areas. —>

A strong consensus is needed to develop a vision of performance that we will use to set goals. Along with the vision is a requirement to understand the elements of manufacturing systems that we will use as building blocks to ultimately identify and prioritize enabling technologies. We have decided to commit $6 million to this up-front effort.

I think we are learning from the Japanese model that more effort needs to be made early in the goal-setting and planning-stages before we march off. Two technical thrust areas emerge with strong support from nearly all participants—composite materials fabrication and precision machining and forming. As a result, we have committed $18 million in these areas.

The third technical area identified as vitally important is electronics, but the optimum strategy focus for MANTECH was less clear. It is not enough to identify important areas. We have to take the issue further.

The real question is what impact can the MANTECH program have on advancing electronics manufacturing. We are funding one project for continuous improvement of gallium arsenide for $1 million which we felt would make a difference. The larger question in

terms of strategic direction for the program is being answered by a DOD team led by the Army.

We will be much more definitive in the final NDMT plan. We have assembled the right players with the right attitude. We have developed a process which is working to deliver the National Defense Manufacturing Technology Plan by October. We are already taking actions such as interagency cooperation and internal management to take advantage of what we are learning. The outcome, Mr. Chairman, I believe will be a strengthened MANTECH program, better positioned to make substantial contributions to improve costs and quality and to reduce cycle time for our future weapons systems.

Thank you for the opportunity.

[The prepared statement of Mr. McMillan follows:]

PREPARED STATEMENT BY HONORABLE COLIN MCMILLAN, ASSISTANT SECRETARY OF DEFENSE (PRODUCTION AND LOGISTICS)

Mr. Chairman and members of the subcommittee, I appreciate the opportunity to discuss with you our defense manufacturing technology program. I know from the past activities of this subcommittee that we share similar views on the importance of manufacturing to America's military power, and more broadly, to our international competitiveness.

Today, manufacturing technology is commanding increased attention. In a time of decreased defense budgets, the trend in defense systems is increased performance, and higher costs, resulting in fewer weapons within a constrained budget.

An important part of the Department of Defense (DOD) response to this problem is the Manufacturing Technology (MANTECH) program. The Fiscal Year 1991 National Defense Authorization Act called for the development of a National Defense Manufacturing Technology (NDMT) plan. I will update you on our activities responding to these legislative requirements.

It is private industry that must make the necessary long term investments to develop the next generation of manufacturing tools, to develop process together with product, and promote quality and efficiency hand-in-hand with performance. The DOD role is to facilitate this transformation in areas important to our Nation's security. Within this context, our MANTECH program, and eventually the NDMT plan can play an important role.

The Fiscal Year 1991 National Defense Authorization Act requires DOD to develop a National Defense Manufacturing plan. It has several objectives. In brief, these are to (a) provide guidance on defense manufacturing technology goals, priorities and procedures, (b) provide a link between defense manufacturing technology efforts and industrial preparedness programs, (c) improve manufacturing technology transfer, particularly to subtier suppliers, and (d) coordinate the development and implementation of this plan with appropriate agencies and departments. The act also established an Office of the Secretary of Defense (OSD) manufacturing technology funding line of $50 million, to be allocated in accordance with this plan.

These requirements are, I believe, a logical extension of DOD's MANTECH program, as we have previously presented before this subcommittee. MANTECH, averaging approximately $160 million year over the past decade, has a solid record of achievements in putting improved defense manufacturing processes in place on the factory floor, achievements recognized within the DOD community and by industry. As an example, the American Defense Preparedness Association recently credited the program with far reaching accomplishments including: (a) the establishment of Automatically Programmed Tools (APT), which became the de facto industry standard for numerically controlled machine tool programming; (b) production of components for the first integrated circuit calculator, which led to numerous advances in the electronics industry; (c) development of the ion implantation process used for manufacturing delicate electronic circuits; and (d) establishment of isothermal forging for producing titanium and superalloy structures.

MANTECH developed the technology of utilizing fracture mechanics and advanced nondestructive test techniques to enable the retirement for cause of spare parts for turbine engines rather than retirement after a specified service life. In other words, this technology allows the replacement of parts when actually needed rather than when the book said so. This results in extending the use of components,

increased engine availability, fewer spare parts for inventory, and reduced use of critical materials. The Air Force estimates that $1 billion has been saved by this "retirement for cause" automated inspection technique. The return from this single application exceeds the Air Force funding for the entire MANTECH program since it began in 1947. In short, almost every weapon system in our inventory has directly benefited from these "bottoms up" MANTECH enhancements. MANTECH has directly and consistently returned more to the taxpayer than it cost.

As good as this program has been, it has the potential to be even better. Your legislation suggests a number of ways towards realizing this potential by coordinating MANTECH efforts around a central "top-down" strategy. Fortunately, we had been and are moving in that direction. We are building on efforts the services already have underway. During the past 2 years the services and DLA MANTECH programs have developed their own strategic thrust areas. One way to improve these efforts is through better coordination of the individual manufacturing technology thrust areas. For example, each service currently has MANTECH projects dealing with composites materials. We recognize that service unique composite requirements exist. But we also recognize that more efficient use of resources could result by better communicating and coordinating the development of manufacturing processes for composites, both among the services and with other government sponsored programs.

To this end, Mr. Yockey, the Acting Under Secretary of Defense for Acquisition, chartered a task force to review the overall MANTECH program, develop the congressionally requested NDMT plan to serve as a roadmap for MANTECH investments over the next decade, and develop a management plan to achieve effective implementation of the task force recommendations. The task force had its first meeting in January and will meet monthly through July. It has representatives from the OSD (including the offices of the Director, Defense Research and Engineering (DDR&E), Computer Aided Logistics Support (CALS), Defense Advance Research Program Agency (DARPA), and Strategic Defense Initiative Office (SDIO)). It also includes the services, and the Defense Logistics Agency. To assure that other agency manufacturing interests are acknowledged in our planning, we also have as full task force members representatives from the Department of Energy, the Department of Commerce (including the National Institute of Standards and Technology (NIST)), the National Science Foundation, and NASA. While formal development of the NDMT plan has just begun, there has already been benefit derived from the communication among task force members on manufacturing concerns and initiatives across the broad array of organizations.

In developing its basic strategy, the task force will consider three primary factors: (a) manufacturing barriers, (b) opportunities, and (c) vision. The first two of these strategic components will be derived primarily from a survey of 30 major defense programs, cutting across all services, which comprise the bulk of our defense production costs. Development of the visionary data will come from internal DOD technology plans, and surveys of both national and international manufacturing experts.

The search for MANTECH barriers and technology gaps follows essentially the traditional "bottoms up" identification of manufacturing process problems that must be solved to meet DOD's defense production requirements. An example of such a barrier is the requirement to automate the manufacture of Transmit-Receive (TR) radar modules, large numbers of which will be required for the phased array radars of our next generation aircraft. The Advanced Tactical Fighter (ATF), for example, will use 2,000 such TR modules in its radar. But since TR modules are presently projected to cost $3,500 apiece to manufacture, the cost of the modules alone are over twice the target cost of the entire radar system. MANTECH projects are being directed to reduce the manufacturing cost by nearly an order of magnitude. The specific goal is to achieve a cost of less than $400 per module in full production lots. This is a good example of the impact the MANTECH program can have in fielding our next generation weapons.

At the same time, we will be identifying manufacturing "cost drives," that is, those areas of high manufacturing costs cutting across all services and programs which provide exceptional opportunities for cost savings. Cost data are usually not collected in this manner and, to my knowledge, this is the first time we have tried to document this type of manufacturing cost data within the DOD.

Finally, we are surveying experts to determine the vision of defense manufacturing processes 15 years from now. Through this process, we hope to identify defense manufacturing needs.

These defense manufacturing barriers, opportunities, and visions will be identified this summer. We will synthesize this information into a roadmap for defense manufacturing technology investments. One of the most difficult jobs the task force faces

is developing a methodology for evaluating and prioritizing a large number and variety of potential process technologies. Impact, leverage, critical mass, and timing are just a few of the factors that must be considered. The resultant investment roadmap will be the core of our strategic plan. We expect this process will strengthen the MANTECH program significantly, and logically chart defense manufacturing investment requirements and opportunities for the decade ahead.

As the investment roadmap comes together, the task force will also develop a plan to efficiently implement the investment roadmap recommendations. Within this effort, we are looking for new and innovative ways to better measure MANTECH's true "Return on Investment (ROI)." While strict dollar savings and cost avoidance are the traditional measures, most people involved with the MANTECH program feel that the benefits extend much broader and deeper into both our defense and commercial manufacturing infrastructure. Additionally, we are examining the OSD, service and DLA MANTECH management structures to see if it makes sense to change any of the current organizations. We do not want to disrupt the effective activities the services have in place, but we will also not hesitate to revise the existing structure if it is clear that we can meet our MANTECH objectives more efficiently and effectively. What is emerging already is the opportunity for some change in our traditional management approach to effect a DOD corporate approach on the interim projects selected. We have started to explore the use of tri-service arrangements for project oversight to assure individual projects are maintained as part of an overall thrust, rather than simply stand-alone efforts.

We will revise and reissue the DOD instruction on the manufacturing technology program, to make sure all new policy guidance is clear and unambiguous. And finally, we will continue the interagency exchange of manufacturing information begun with this task force.

Mr. Chairman, your letter also specifically asked about the use of manufacturing extension services. Last year's legislation required us to examine this topic. We are doing so as part of the task force's efforts to improve defense manufacturing technology transfer. As an acknowledgment of some of the innovative work being done, and to reflect our desire to bring new thinking into the area of technology transfer, we have asked the Department of Energy to chair our task force efforts on technology transfer. We will be learning the successful technology transfer techniques of the public extension services what may be applicable to the MANTECH program. This area has great potential for expanding MANTECH's return on investment. The Tech Transfer Committee will recommend specific initiatives, with an evaluation of how manufacturing extension services may assist our MANTECH program, particularly in transferring technology to subtier suppliers. We will include these results in the NDMT plan.

As I mentioned at the beginning of this testimony, Congress provided an OSD MANTECH program line of $50 million in fiscal year 1991, to be allocated in accordance with the NDMT plan. This OSD funding has provided needed emphasis for the task force activities. However, the NDMT plan will not be completed until the end of this fiscal year. As you know, we have worked out an arrangement for an interim release of funds on long-range process technologies of significant importance to DOD. We have taken advantage of service planning already done to get an earlier start in solving critical process problems that we know are currently facing the Department and will continue to do so for the foreseeable future. We also decided to hold the balance of the $50 million until our direction is more completely defined in the final NDMT plan.

To make the interim allocation, we conducted a technical competition from the entire DOD manufacturing community. We received proposals from the Army, Navy, Air Force, DLA, DARPA, and SDIO. We asked for long range, generic process technologies that could provide, or lay the foundation for, step-function improvements in reducing defense manufacturing costs, decreasing cycle times, and increasing quality. A constraint that limited proposals was that they must be obligated this fiscal year. In response, we received 53 proposals requesting nearly a quarter of a billion dollars for fiscal year 1991, and nearly three-quarters of a billion dollars in funding. This community is clearly a rich source of ideas on how to reduce costs and improve quality and cycle time through manufacturing improvements. An executive committee of the task force has carefully evaluated these proposals.

Opportunities emerged in this process that have not historically been considered "MANTECH." These include soft technology areas such as manufacturing engineering, design for manufacturing, technology transfer and education. I think this is an excellent indication that the program is growing, in searching out where the MANTECH program can have the greatest impact.

We wanted the best ideas we could get. We also wanted to make sure we selected the best for funding. To assist us in that decision we sought outside advice, beyond the MANTECH community. We set up what I think was an innovative and effective way to get a broad base of opinion. Our government review team consisted of other OSD organizations such as DDR&E and CALS, the Manufacturing Technology Advisory Group and other agencies, such as the Departments of Energy, Commerce, NIST, and the National Science Foundation. Our review team also received many valuable comments and recommendations from several industry associations including the Electronics Industries Association, Aerospace Industries Association, Society of Manufacturing Engineers, the American Defense Preparedness Association, the National Center for Manufacturing Science, and the National Machine Tools Builders Association (NMTBA).

Thanks to this broad input, I can report to you with confidence that we are committing these funds in both the letter and spirit of legislative intent. Projects totalling $25.5 million were recommended by the executive committee and approved by my office. They are consistent with a developing, long range vision of the MANTECH program. While "bottoms up" MANTECH needs must be addressed by the services, the OSD interim release takes a broader view. It looks toward the strategic vision currently being developed within the task force. This interim release spans the manufacturing spectrum from a top-level definition of the next-generation manufacturing system to enabling technologies.

Starting at the top, the interim release contains $2 million for a Navy-led effort to define a MANTECH system vision, that is, the next generation defense intelligent manufacturing system. This thrust will examine the range of man intelligent machine interface within defense manufacturing scheduling, shop floor simulation, automated assembly and testing. This will be integrated with a system architecture to be defined as part of a $4 million Air Force-led consortia effort on enterprise integration. It will leverage industry efforts in developing "seamless" exchanges of information and data across the vast array of defense manufacturing activities. These two efforts—vision and systems architecture—will provide the long term basis for goals and project selection.

Looking now beyond this top level manufacturing systems architecture into the enabling technologies, the Executive Committee also found general agreement in interim investments in three areas: composite materials fabrication, precision machining and forming, and electronics process control and packaging.

Composites have consistently been a high priority in defense product research. But more needs to be done in composites process development. A total of $10 million of Navy, Air Force and DARPA projects on composite design for manufacturability, bonding, and automated lay-up were selected as part of a composites fabrication initiative. As I mentioned earlier, we are developing a management approach for composites to assure that these projects are conducted as part of an overall program, not simply three individual activities. Specific project goals include reducing fabrication costs by 50 percent, reducing materiel costs by 20 percent, and reducing cycle time by an order of magnitude.

Machining and forming will continue for the foreseeable future as the core of weapon system production. An Air Force-led consortia will extend the precision machining efforts for the next generation controller, and sensor technology for adaptive control. It will also lay groundwork for such areas as high speed high power spindle rates, control of thermal distortion, and ceramic machining. We will investigate ways in the coming weeks to work more closely with the Department of Energy, NIST, and industry to integrate our efforts to achieve significant advances in precision machining for future defense systems.

Finally, the interim project review recognized the importance of electronic components in the increased performance and growing cost of advanced weapons. We funded a $1 million Air Force effort for continuous process improvements to lower the cost of gallium arsenide high power amplifier chips, solar cells, and fiber optic gyros.

Clearly, a significant issue is where the MANTECH program could have an impact given the tremendous resources directed to electronics by industry and elsewhere in government. A possibility is electronics packaging, an area being analyzed through an effort led by the Army. This process will enable our corporate effort to take advantage of individual service activities, such as the Air Force strategy 2000 plan for electronics, to develop an overall strategy. The results of this project will be included in the final NDMT plan.

We believe the interim release of $25.5 million described above will provide an effective transition to the type of strategic planning and cooperation being developed within the NDMT plan. Another way of looking at the above projects is that $4

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million was allocated to design tools, $4 million to processes, $11.5 million to manufacturing systems, and $6 million to information integration. The remaining funds will be allocated when the NDMT plan is completed.

Throughout the preliminary task force and interim release activities, we have been particularly encouraged by the cooperation of the various DOD participants, particularly the service MANTECH directors. Everyone involved recognizes the importance of manufacturing to our future military systems, as well as to our Nation's commercial endeavors. We believe the National Defense Manufacturing Technology plan is off to a good start. We plan to provide you more details in an interim report in another month or so, and hope to have the NDMT plan approved and forwarded to you by October.

Manufacturing is important to the Department of Defense. It is important to America. DOD's MANTECH program is just one of the tools available to promote process improvements that can significantly reduce the cost, enhance the quality, and shorten the lead times of future defense systems. In a tightly constrained budget environment, I think it is essential that we have a strategic plan for MANTECH. While the National Defense Manufacturing Technology plan and task force activities are a very ambitious undertaking, I believe we have a good team assembled, and that they are up to the challenge. We will look forward to working with you to implement the task force recommendations.

Again, I appreciate the opportunity to speak with you this morning. I will be happy to answer any questions.

Senator BINGAMAN. Thank you for being here, and I appreciate that testimony.

Let me start by asking about the funding level. We put significantly more funds in DOD's budget last year for manufacturing technology and manufacturing modernization than we ever had before. In the current year you have a total of $305 million, as I understand it, that was appropriated for manufacturing extension programs in the three services, OSD, and the Defense Logistics Agency.

My concern is that the funding level was up from about $150 million in the previous year. The request we received from the administration in the 1992 budget is to decrease to $97 million, which is not only below what we had appropriated and authorized, but it is substantially below where you were last year. If anything DOD is cutting back in this area of funding and giving it lower priority than they had in previous years.

My question is whether in fact this is some indication of the lack of interest or intent to somewhat phase out the MANTECH program. What is the explanation for the budget request that we received this year?

Mr. MCMILLAN. Well, Mr. Chairman, it's certainly not a lack of interest in MANTECH. The Department recognizes the value of MANTECH, that there is a clear payback. In terms of analysis, the budget last year was $315 million, $115 million of which were specific projects or directed projects. $50 million was for the program that we are presenting today and there was the $150 million that we had requested.

In terms of looking at the budget in a longer period of time, I think it is fair to say that a 2-year average for this fiscal year and next fiscal year would be well over $200 million, which is higher than we have had in any time—I have done some checking—in the last 10 years. So while our request is going down next year clearly because of budget restraints, I think our overall emphasis on MANTECH is undiminished.

Senator BINGAMAN. Let me just ask your reaction. I had dinner last night with members of the Semiconductor Equipment Manu-

facturers Organization, which is having its annual meeting in town. There are about 900 to 1,000 companies around the country that produce the equipment that the semiconductor industry uses. As you know, we are funding, through the Department of Defense, $100 million a year to Sematech to try to maintain both a semiconductor capability and a competitive semiconductor industry. I think Sematech has had some successes.

But the concern I have after having dinner with some of these gentlemen was that, while we may maintain a semiconductor manufacturing capability, all of the equipment that those semiconductor firms are going to need in order to be competitive will have to be purchased abroad. We are not to that stage yet, but it is clear that more and more of the equipment that they are having to procure, they have to buy elsewhere because the manufacturing firms that support the industry are going out of business because they cannot compete with the Japanese, in particular, but also with some other foreign sources.

Is this kind of erosion of the manufacturing infrastructure which is needed to produce the weapons that the Department of Defense relies upon a concern to the Department of Defense?

Mr. McMillan. I would tell you, Senator, that as I have gone through the country and looked at some of our production plants—that there are some foreign, particularly Japanese, instrumentation being used to make electronic components.

I would say in the case of American industry, that overall American industry productivity, is improving. I think that in terms of the Defense Department, there are going to be less dollars to spend. It is something to be concerned about. To the extent of the concern, I really do not know. I do know clearly that there will be less money to address the problem. But I guess—at this point I would say that while we are concerned about it, I do not think we are overly concerned.

Senator Bingaman. Last year we also tried, through our legislation, to shift focus and really accountability and responsibility for management of the manufacturing activities in DOD to the Office of the Secretary of Defense with the $50 million that we put there. As I understand it in the budget requests this year, there is no request for additional funds in this OSD line. Is it your thought that that was a mistake? Should we not try to concentrate this in the Office of the Secretary of Defense? Our thought was that centralizing the responsibility at least somewhat in this area would result in an improved, better-coordinated, better-planned effort at manufacturing. Is that contrary to your views?

Mr. McMillan. Well, Mr. Chairman, NDMTP will still be—the plan we are developing will still be in my office. So I am not concerned particularly that the funding is not there. The emphasis will still be there. Obviously, I would be less than candid if I didn't tell you that money certainly gets people's attention. But we are satisfied with where the money is put.

Senator Bingaman. Senator Coats.

Senator Coats. Now, Mr. McMillan, over the past several years studies have been conducted, one by the American Defense Preparedness Association, pointing to a need for a strategic planning process for MANTECH, to fill the gaps and reduce the duplication

in manufacturing technology programs. And this is pretty much been described as a bottom-up process, the fact the National Manufacturing Technology Plan was intended to establish that sort of planning process.

I guess my concern with balancing the top-down and bottom-up approach to manufacturing technology programs, clearly a strategic approach is needed, but I am wondering if we risk missing some very important shorter-term cost-cutting opportunities by having strictly a top-down approach. I am wondering if you could comment on that and give me an indication of how we might be able to balance that. I mean, I see the need for the strategic top-down planning process, but I am wondering if we might not jeopardize some advantages we might receive by so-called bottom-up approach.

Mr. McMillan. Well, first, the American Defense Preparedness Association was consulted in this process, along with some other industry groups, so there were a number that were involved. And I would tell you that this—the NDMTP—is both a bottoms-up and top-down process, so I think we are going to get a look at the large plan as well as specific programs. We are allocating 75 percent of the money for top-down and leaving 25 percent for bottoms-up.

Senator Coats. And you are confident that proportion will give you that balance you are looking for?

Mr. McMillan. Well, Senator, I guess I would say that I think we are off to a reasonable start. And I think frankly, as I said in my opening remarks, we have a broad-based look at this thing and the chance for some pretty wide input. We are going to monitor it, but I think that is the consensus that we started with.

Senator Coats. Is that decision flexible? If you find that that is not giving you what you need, can you modify that allocation?

Mr. McMillan. Yes, I think we have allocated $24 million of the $50 million so in terms of what we have left, it is flexible.

Senator Coats. There has been some recent discussion in the Department of Defense about putting the responsibility for coordinating the prioritizing MANTECH programs in the Office of the Director for Defense, Research, and Engineering. Can you give me current status on that thinking?

Mr. McMillan. Well, that question came up and I do not see any substance to that, Senator. I think the plans are right now for it to stay in Production and Logistics. And I think that is where it belongs. You know I may be proved wrong, but I do not know of anything substantial going on other than to keep it where it is.

Senator Coats. Does or should research and development play some role in the process?

Mr. McMillan. Sure, I think they should, and I think they are. I think what we are working on right now is bringing DDR&E into the process, so there needs to be a hand off between R&D and production. And we think MANTECH is a production function and not a research function.

Senator Coats. And you are pretty confident that that will be retained in current structure?

Mr. McMillan. As confident as I can be. Frankly, I think we got that question early on from you, and I did some research on it. I cannot find any substance to it.

There are an awful lot of rumors that are in the Pentagon, Senator.

Senator COATS. A lot of rumors around here, too. [Laughter.]

Senator COATS. I guess we all deal with that every day.

Mr. Chairman, that is all I had. Thank you.

Senator BINGAMAN. Senator Smith.

Senator SMITH. Thank you, Mr. Chairman. In your testimony, Mr. McMillan, you talk about a visionary-type meeting where you look ahead 15 years from now as to what our needs may be. Can you give us any insight into that—a few specifics as to what manufacturing technologies, other than the obvious ones, computers and so forth—that you perceive to be critical in our defense establishment over the next 20 to 30 years.

Mr. MCMILLAN. I think I might ask Mr. Kimzey to answer that. I can tell you that we are looking at a number of programs that we see out in the future. I think 30 programs are being reviewed to anticipate the sort of technologies that we might need. In some cases, some of our new radars, for instance, we are anticipating that MANTECH is going to bring the cost down so that we can in fact bring those things on line with some our future weaponry within a reasonable budget. Mr. Kimzey?

Mr. KIMZEY. Senator, what we are after in that exercise is to look at both the specific weapon systems that were mentioned, the nearer-term requirement, and to go beyond those requirements by looking at the next generation production system in a generic sense.

Despite the fact that we would like to have a completely captive industrial base to perform all of DOD's requirements, there is a general prediction that there will be a global manufacturing and distribution system. A captive base does not appear to be in the cards, and DOD, in order to meet its mission, is going to have to deal with a global manufacturing system.

By looking at a distribution process, a manufacturing process, a design process that may be distributed internationally, what we are trying to understand is how that process would work, and then what kind of accommodation the Defense Department has to make to assure that we can meet our mission statements.

Now, that is a vague answer to your question, because we do not have it down in terms of specifics. We are looking at things like system performance, rapid prototyping, being able to produce economic order quantities of one. The kind of performance that you would like to see out of a manufacturing system is what is going into that question. Then we are trying to use expert opinion to look downstream. What we are attempting to do here is to set a vision that would form the platform for manufacturing technology investments, enabling us to look longer term than traditionally we have.

Senator SMITH. Can either of you try to relate that somewhat, especially your reference to a global economy, to the B–2 program and the technology there. What lessons have we learned from this design and the manufacturing strategy there? And how—with a weapon like that, stealth and secrecy—how do you deal with that on a global market? How do you justify a weapon that is stealthy if everybody else has the ability to break down the stealthiness because the technology has proliferated?

Mr. TORELLI. I will try that, Senator. The B–2 did some very good things—up-front design to cost and some planning and logistics. The composite side of B–2 was an issue. In fact, they are advancing the manufacturing process with the B–2. They are learning a lot, and we are learning. Of the $50 million released, we have allocated some of the money toward composites in three different areas, each being led by a different service.

The Japanese are spearheading some of the technology, not the United States. However, the classified portions—I think this is really the kind of question you are asking—the classified portions are what we need to try and protect.

So our efforts are to make as many advancements as we can across the board, and make sure that we protect the things that we think are important for national defense. And that is part of what we are trying to manage, and also because we fit within Mr. McMillan's organization underneath the acquisition process, the Defense Acquisition Board, we can interface with DDR&E and the DAB process in terms of making sure those kind of programs can continue.

Senator SMITH. Can we—picking up on the chairman's question earlier—can we maintain the competitive edge in the technologies that we had in this last conflict in the Persian Gulf with these types of budgetary constraints? I know that is a tough one, but I am concerned about it. I think many Members of this committee and the Senate are concerned about it, as to whether or not we are going to throw away a competitive edge that we had.

Let me put it in a specific question—is there enough focus on R&D in the budget?

Mr. MCMILLAN. Senator, I think there is. I think clearly Secretary Cheney has indicated that we are going to continue with the high-tech sort of weaponry that we have had. There is a commitment as we draw down forces to be sure that we leave a significant part of our budget for such efforts. I would tell you that they will come down, but they are clearly not going to be lost.

I guess I have had that emphasized, not only from Secretary Cheney, but Secretary Atwood and others in the Department, that we think that is very important. Desert Storm just strengthened that. The strength of our technology was brought home to America and to the world very clearly.

Senator SMITH. All right. Thank you.

Thank you, Mr. Chairman.

Senator BINGAMAN. Let me just comment, and if you have a comment on it, go ahead. The idea that you folks are going to take a full year to do this plan was not anything that I had in mind when we wrote this legislation. I do not know if that is normal practice around the Defense Department these days to take a full year to prepare a plan of action. I am glad we did not take that approach in the Persian Gulf. Is there a reason why this has taken a full year to do? Did we not have any idea what we were doing in manufacturing before this? Or is it just that low a priority?

Mr. MCMILLAN. Mr. Chairman, a couple of points. One is that I think we moved out pretty smartly on the implementation. The letter was signed out by Mr. Yockey in December. I think the

budget was passed late November. We contacted the other agencies. And we did move out smartly, I think.

Frankly, one point that I made in my testimony is that other people with high-technology skills, particularly the Japanese, have in the past spent an awful lot of time on the front-end planning. And I think at least that was part of our philosophy. I think we are moving ahead with this, and the fact that we have released about half the money and having the program in effect for about 3½ months, is not a bad record.

Senator BINGAMAN. As I think about the manufacturing technology, I think of it in two large categories. One is the R&D activity to try to develop the new manufacturing processes that we need. The other is the extension effort which ensures that it gets to people who need that information and that practice.

We have a provision in the bill that we passed last year calling for manufacturing extension programs to assist the sub-tier defense industry. What is being done to implement that?

Mr. MCMILLAN. Well, first—and I might have Mr. Torelli go into a little detail on that—but first, Dr. White testified about the cooperation between us and Commerce. And in this effort, I think it is important to continue that relationship. We—Dr. White and I—have met on a regular basis since he has come into office, discussing individual MANTECH and CADCAM/CALS issues that relate to the defense industry that can be used by American industry in general.

So at least some of our effort will go to cooperation with Commerce, where an awful lot of responsibility beyond the Department of Defense lies.

Nic, could you carry that a little further, please?

Mr. TORELLI. Yes, sir, a couple things. As Mr. McMillan said in his statement, we have taken that piece of the work and said, okay, Energy, Commerce, help us out with this, because you have more experience doing this than we do. The synergy that we have had already with the Commerce and Energy people, also NASA and some others, has been really good in the generation of this plan. They are going to help us by really taking the lead. There is a committee—a subcommittee of our group—that is working on this right now.

The purpose of MANTECH is to buy technology for DOD and we are trying to keep that in mind and keep moving in the direction of extension services at the same time. And those things do not fit directly.

Senator BINGAMAN. As I understood Dr. White's statement, he said that Department of Commerce is putting about $10 million into the five manufacturing technology centers. In addition, they are trying to facilitate or be a catalyst for all these other activities which they are not putting any money into.

Out of the $305 million that DOD is spending on manufacturing, how much of that goes to extension?

Mr. TORELLI. We do not have a number yet, sir. That is part of the other $25 million as we work the plan up and go off and do some dissemination, but right now we do not have a number yet.

Senator BINGAMAN. But you have nothing going in this year?

Mr. TORELLI. No——

Senator BINGAMAN. I am not talking about next year. I am talking about—

Mr. TORELLI. There are efforts going on in the services, and we will go back and get some numbers and supply those for the record. But we do not have the exact numbers.

Mr. MCMILLAN. I think maybe we can get Chuck to give you a better answer.

Senator BINGAMAN. Okay.

Mr. KIMZEY. Senator, the efforts the MANTECH program has engaged in to date on technology transfer have been through things like end-of-contract demonstrations. When we reach an end of a project, we will write a report and we will make sure that it is distributed to American industry. We have funded our own technology transfer organization called the Manufacturing Technology Information Analysis Center, whose job it is to transfer our technology to American industry, particularly to the small business.

We have not used the extension services as a technique, as a tool in the MANTECH program to date. So in answer to your question about explicitly how much money is going to the extension services, the answer is virtually zero. You asked us to do an analysis of the extension services to see how they might be used in the program, and that is what we are doing.

Senator BINGAMAN. We had testimony last year from Mr. Willoughby with the Department of the Navy about his efforts to upgrade the manufacturing capability of the companies that sell to the Navy. He described the templates that they have prepared that set out the so-called best practices. I gather he has had the Bell Laboratories help him to put those in notebook form for distribution.

Do you folks have a position on the value of what he has done, the usefulness of it across the other services, the usefulness of it throughout industry, not just in DOD? He feels very strongly that he has done something useful here, and I'm just wondering if you agree?

Mr. TORELLI. Will's guy is on our committee, and the best practices booklet is a nice well-done document that is being distributed now within Defense—the best practices initiatives are going on across all the services. We feel that because of the participation of Will's people in our committee, we are flowing that out better, quicker. Having been in industry, I know we used the best practices templates and they do make things go better. It is almost like a check list. And it is very helpful. And that data, that information, is getting out to industry.

Senator BINGAMAN. Will that type of approach be a part of what you come up with in your plan, or is that not being considered.

Mr. TORELLI. As the plan comes together that is a piece of it. So I guess the answer is, yes, sir.

Mr. MCMILLAN. And we are paying for that. That is being paid for out of MANTECH funds—best practices.

Senator BINGAMAN. No, I know it is. I am just wondering if it is very different than your traditional use of MANTECH funds. It seems to me to be perhaps a more useful way to spend some of those dollars than what we have traditionally done. That is what I was asking about.

Mr. McMillan. We are clearly willing to be innovative, Senator. And our focus is going to be on weapon systems, and the DOD. We are working very hard to be innovative.

Senator Bingaman. Senator Coats.

Senator Coats. I have no further questions, Mr. Chairman.

Senator Bingaman. Senator Smith.

Senator Smith. Mr. Chairman, I have one additional question.

Senator Bingaman. Sure, go ahead.

Senator Smith. Thank you.

Of late there appears to be quite a substantial reliance of DOD on foreign suppliers on some of the high-tech weapons components. As a matter of fact, there were press reports during the war that we were forced to approach the Japanese and other European nations for rush orders of computer electronics and some other sensitive spare parts.

Couple that with the fact that many manufacturers are looking to foreign countries to leave—literally leave the country and go to foreign countries and set up plant operations due to better labor—no, not better labor but cheaper labor and better tax situations. What are we doing to deal with that? How do we propose to deal with that over the next few years? I think that is going to be a substantial problem.

Mr. McMillan. Well, Senator, there is reliance on foreign suppliers from time to time, but not dependency. I think we do have some flexibility now, and we are going to try to maintain flexibility. One of the things we are doing in the CALS area is to be able to manufacture electronic components and other parts, in a one-of-a-kind type of manufacturing system or small lot manufacturing techniques for replacement parts.

So while there is reliance, I do not think that the dependency is there. It is an issue frankly we are going to have to follow very closely and be sure that we do not go over that line.

Senator Smith. I have never carefully reviewed both words in the dictionary, but reliance and dependency, there is not a hell of a lot of difference between those two words, as far as I can see.

Mr. McMillan. Senator, if we got foreign parts and we got parts in weapon systems that we are buying from foreign sources, then we have to worry about relying on them to help us make and maintain those weapons systems.

When we put our systems to use, one of our biggest concerns is the spare parts. And we need to have a system, and that is a lot of what CALS is all about, to make those spare parts. I would submit in many cases, although American manufacturers are exporting their manufacturing of a particular product, the technology is still here in the country and can be brought up.

I do not think it is a play on words. I think we frankly can get what we want now. During the war we looked at that issue and found no serious wanting. And I am not saying that we do not need to continue to monitor it, because it could become a serious problem.

Senator Smith. Thank you. Thank you, Mr. Chairman.

Senator Bingaman. Let me just follow up on that a minute. I agree with you that the technology is here, but in a lot of areas the ability to produce the product is not here anymore. For example,

flat panel displays. We have no ability in this country to produce those. We have no company that is willing to take on the job of developing that, because it is such a competitive arena. Also, the capital investment is so enormous that we have essentially just concluded that we will buy all of our displays from foreigners from now on.

Now, I guess that is just reliance and not dependency, but it strikes me that we do know how to make them, but we certainly cannot produce them in quantity to field in a wartime situation unless we have a couple years' notice that we are going to have a war. If you know anything contrary to that, I would be anxious to hear it. That is my information. If I am wrong about that, please correct me.

Mr. McMillan. I really cannot comment specifically on that, on those panels that you are talking about, but I would be glad to take that for the record and see if we can get you a better answer, Senator.

[The information follows:]

DOD MANTECH Flat Panel Displays

A report to Congress on the defense industrial base dated October 1990 titled, *Critical Industries Planning*, recognized both the importance of flat panel displays and the lack of a credible U.S. industrial base.

The report points out that while much of the flat panel display technology was initially developed by U.S. companies, many of them, under intense pressure from foreign competition, have either ceased to exist or have ceased to develop and manufacture flat panel displays. Today, nearly 98 percent of flat panel displays used in the United States are shipped from Japan.

Efforts are underway at the Defense Advanced Research Project Agency (DARPA) to address this shortfall. Since 1989 over $110 million has been directed at providing U.S. companies advanced manufacturing capabilities to meet defense needs for flat panel displays.

DARPA has concentrated its efforts on the manufacture of flat panel displays, data compaction, and the development of processors needed to manipulate the large amount of data required for flat panel displays. It is believed that this work will bring the right people together and plant the seeds necessary to provide a U.S. capability to meet future defense needs.

Senator Bingaman. Is it fair to say—and again this is not to be argumentative—but I think just a fact based on all the snooping around I have done in the last few years. The Department of Defense does not know what it is having to purchase from abroad and what it is buying from domestic producers regarding any of our weapons systems. Basically there is no weapons system that I am aware of where the Department of Defense can say these items are sourced from overseas and these other items are sourced from domestic producers here. Am I right about that? As far as I can tell that is the case.

Mr. McMillan. I think you are correct, Senator. I think on any one given weapons systems or any one given electronic component we can go back and do that research and find out where they came from. But if you were to ask the people that operate that system where they came from, I think you have the right answer.

Senator Bingaman. For example, does the Department of Defense know what percent of the Patriot missile is produced overseas?

Mr. McMillan. I do not know the answer to that, and I do not think it has been discussed. Although, we have had discussions that there is a significant percentage of foreign parts in the Patriots' electronic components—we recognize that.

Senator Bingaman. Senator Coats.

Senator Coats. Mr. Chairman, I just want to jump in here.

Senator Bingaman. Sure.

Senator Coats. Because I think a very important point has been raised to which we do not know the answer. And it is a very complex question, and it is a function of inventory. It is a function of how critical a particular part or parts might be to the functioning of a system, how critical that system might be, and what alternatives exist. But I think it is an important question, because any nation that either does not know or, even if it knows, does not have the capacity to produce strategic parts at critical times could find itself in a real difficult situation.

And I am not exactly sure what the mechanism would be for identifying what those strategic components and strategic parts are. I know we do it with raw materials, but I do not know that we do it—I mean, we are not—we are well beyond that in terms of our systems today. And I just think that is a question that ought to be pursued.

Mr. McMillan. I might hand that off to Mr. Torelli.

Senator Bingaman. Yes, go ahead.

Mr. Torelli. A couple of things. We, as a result of your request from last year, have done some in-depth analyses down below the sub-tier—the first-tier, second-tier level suppliers. And in a quick look, you do not find much percent-wise in terms of foreign sourcing. As you get deeper into the sub-tier, third, fourth level, fifth level, some more of that arises, in sub-electronic components in particular.

Our initiative—and you said it very well, Senator, when you were talking about this is not an easy problem—goes back to affordability a lot. How much can we buy overseas that can be done now, as opposed to gearing up a whole industry and protecting ourself. And the real key is the criticality of it versus the affordability of it. We are trying to streamline a process and make it work better, cheaper. Better and cheaper together make it very difficult to do.

Senator Bingaman. Is it fair to—go ahead and complete your answer.

Mr. Torelli. Well, we are trying to spend more time looking at that now. In fact, I have commissioned some people within our organization to spend some more time looking into the details of that to find out if there are specific dependencies. And that exercise is ongoing right now.

Senator Bingaman. Do you have any information you could give the committee about what you have found in particular weapons system as to the extent of the foreign components?

Mr. Torelli. I do not have it right here, sir, but I think I can supply some of it for the record.

Senator Bingaman. No, I do not mean right here, but I mean that you can provide to us?

Mr. Torelli. Sir, I think we can.

Senator BINGAMAN. That would be useful. I would appreciate seeing that.

[The information follows:]

DOD DATA SYSTEMS

The exercise referred to are efforts underway to improve the DOD industrial base data system to enhance our visibility into the subtier base, and thereby better understand the extent of foreign sourcing. To this end, we are searching out available data bases which can be incorporated into our DOD data system. We have identified 11 such data bases which have the potential to improve our subtier assessment capability.

Regarding specific foreign sourcing, a recent study performed for DOD examined four types of defense systems—cockpit displays, aircraft radar, air to air missiles, and heavy combat vehicle engines. To the extent that foreign sourcing was identified, it was mostly below the first and second tiers of supply. Cathode ray tubes (CRTs) for F-18 and AV-8B cockpit displays depend on foreign sources for key components such as filter glass, molded ferrites, glass bulbs, optical filters, phosphors, glass funnels, and faceplates. Microelectronic devices used in the missiles, radars, and displays were almost totally dependent on foreign sources for various packaging materials, including ceramic packages, lids, and covers; lead frames used on semiconductor discrete and IC devices. Extensive foreign sourcing was noted for process equipment used to produce mechanical and electronic components as well as machine tools. There were no foreign parts or components technologies identified for the engine systems that constitute a defense system vulnerability.

Senator BINGAMAN. I am just informed you are going to be back here next week.

Mr. TORELLI. Yes, sir, I am.

Senator BINGAMAN. So we will ask you again then.

In this issue of coordination with the Department of Commerce, Dr. White made the point, which I thought was correct, that it does not make sense to have one effort going forward with Defense, a separate effort going forward with Commerce, and certain companies being able to take advantage of one and others being able to take advantage of another, to the extent defense is going to be active in trying to assist in the improvement of manufacturing competencies.

Do you basically agree that this is one ball of wax and we need to approach it as such?

Mr. MCMILLAN. Well, I do, Senator, except for those things that are classified manufacturing techniques. Clearly, we need to do that, and I think you have seen some emphasis from my office to try to do that. For instance, in the CALS effort I have been out to the Sandia Lab and discussed our efforts and CALS.

I think we want to get as much bang for the buck as we can get, and frankly where we can get other agencies to pay to help us, we are going to do it.

Senator BINGAMAN. Senator Smith, do you have some other questions?

We appreciate your taking time to testify. I think it has been very useful testimony, and we will continue to stay in touch with you on this.

Mr. MCMILLAN. Thank you very much, Senator.

Senator BINGAMAN. Thank you.

This is Mr. Lawrence Rhoades, the president of Extrude Hone Corporation.

Mr. Rhoades, thank you for being here. We appreciate it, and we are anxious to hear your testimony. Why do you not go right ahead?

STATEMENT OF LAWRENCE J. RHOADES, PRESIDENT, EXTRUDE HONE CORPORATION

Mr. RHOADES. Thank you, Mr. Chairman, for inviting me to testify before your subcommittee on a program that I believe is of great importance to our defense industrial base.

I am Larry Rhoades, the president of Extrude Hone Corporation. That is in Irwin, PA. Extrude Hone began operations in 1966. We are a small business with under 150 people. We develop and implement new manufacturing processes for nontraditional machining, finishing, and measurement.

Our most current technologies are provided only to our U.S. customer base, but more than half of our equipment sales are to foreign manufacturers, supported by six company-owned technical centers throughout the world.

This gives us a perspective on manufacturing technologies and particularly the implementation of these technologies in large and small manufacturing operations in industries ranging from semiconductor manufacturing equipment to turbine engines to sewing machines in locations from Germany to Japan to Jakarta. We manufacture equipment and consumables as well as offer subcontract machining, using our specialized processes.

My company has been involved with the DOD Manufacturing Technology Program for many years. Mr. McMillan provided you with an overview of the MANTECH program's history and some of its better-known achievements. So I leave the bulk of my comments on that subject to your review of my written testimony.

I would like to mention, however, that the DOD MANTECH program has been the focus of many studies. And they all conclude that the program is a key mechanism for strengthening the U.S. defense industrial base and reducing weapon system procurement costs.

As a result of one study, the Defense Science Board recommended in 1980 that the MANTECH program be funded at a level of 1 percent of the annual DOD procurement budget. At this time, this recommendation would have resulted in annual MANTECH budget of approximately $1 billion. The projected fiscal year 1992 budget of $96.9 million will represent approximately 15/100ths of the fiscal year 1992 DOD procurement budget of $63.4 billion. This small fraction of 1 percent for productivity improvement is not adequate to accomplish the objectives of this program and, in fact, will result in many times this figure being wasted through sub-optimal manufacturing methods.

The U.S. manufacturing base has experienced alarming deterioration during the past decade, and many critically important weapon systems have become dependent on foreign sources for critical components and supplies of materials, as you have been discussing with Mr. McMillan. The Department of Defense has reported that the lead in developing one-quarter of the technologies most essential to American industry is held by non-U.S. firms, and a

growing proportion of the products and components needed for defense comes from abroad. This problem quickly became apparent even in the short Persian Gulf operations. According to a news article I recently read a senior administration official was quoted as saying, "we were sweating bullets over it, and the military was sweating bullets, too." Is it really necessary to subject our military forces to these high-level risks?

It is widely recognized that the economic health and national security of a nation are determined by the strength of its manufacturing base. The long-term viability of a country's manufacturing industries and critical technologies is dependent upon the health of its machine tool industry. In the October 1990 DOD critical industries planning report to Congress on the defense industrial base, machine tools are the most frequently identified equipment essential to the support of the top eight critical defense technologies. Our Nation cannot maintain its economic and military position as a world power if it is dependent on foreign sources for the tools of manufacturing.

The DOD manufacturing technology program is particularly important to the U.S. machine tool industry, for it has been particularly hard hit during the past decade. Although there are some larger companies with sales—annual sales exceeding $100 million, the industry is composed of primarily small companies that do not have the financial resources, especially considering the current financial and economic conditions, necessary to fund urgently needed research and development.

The need is not only to improve the manufacturing technology to make machine tools, but more importantly to advance their role as the developers and implementers of the process technologies performed on their equipment. By producing, installing, and supporting this equipment throughout the defense industrial base, these small technology-focused machine tool builders have the potential to be the most effective carriers of technology to transition new process knowledge to the factory floor.

The typical U.S. machine tool builder has fewer than 100 employees, actually 62 according to the NMTBA, the Association for Manufacturing Technology, with a significantly lower number of advanced degree manufacturing technology personnel than our chief foreign competitors. There are 352 machine tool builders in the U.S. with more than 20 employees. Total industry employment is only 72,500, 33 percent less than in 1980. In the 1980's, the U.S. position as the world's leading producer and exporter of machine tools changed dramatically so that by 1986 the number of machine tools built in Japan alone was almost 10 times that of the United States—39,000 versus 4,000. Today the United States is ranked sixth in machine tool production, behind the Soviet Union, Japan, Germany, Switzerland, and Italy.

Recognizing this problem, but also recognizing the necessity of a viable machine tool industry to our national security, on December 16, 1986, President Reagan took action under authority of section 232 of the trade laws to help the U.S. machine tool industry help itself. He directed the Department of Defense to execute a domestic action plan to assist in the revitalization of the machine tool industry.

As a result of the presidential directive, a major thrust area for machine tool development was established within the Air Force Manufacturing Technology program. To implement this machine tool initiative, the Air Force published a program research and development announcement, or a PRDA, that requested proposals from the development—or proposals for the development and production of new and improved next generation machine tools and manufacturing processes and equipment.

Industry responded with 85 proposals. However, due to limited funding, the first phase of only 10 proposals was selected to be put on contract. My company was one of the companies selected.

Our involvement with MANTECH prior to this initiative began as a subcontractor to Pratt & Whitney to develop methods and equipment to produce low-cost, high-accuracy graphite EDM electrodes for machining complex airfoil shapes in advanced materials for turbine engines. Our effort yielded a new level of precision and flexibility in these machining techniques through substantial advances in machine design.

And our role went beyond that of a mere supplier of equipment. Pratt & Whitney sought our active participation as a developer of new technology. As an equipment builder, we have been uniquely able to responsibly transfer the developed technology to other potential users, not just to other turbine engine builders like GE who is now actively considering the incorporation of the developed technology in an IMIP program at their airfoil production facility. But as an equipment builder with tight technology focus and links throughout the industrial base, we have found applications of this technology to analogous but not so obviously applications in nondefense industries, such as plastic injection molds and pharmaceutical dies.

In 1988, we received the first contract award under the DOD Air Force's Machine Tool Initiative. The objective of our project was the development of a new method for finishing surfaces and edges of complex, high-precision cavities by ultrasonic abrasion using a self-forming abradable tool. The initial focus of the effort has been directed to polishing the compacting tools that form the contoured faces of carbide cutting tool inserts. Our user industry partner for that application was Kennametal.

Although yet to be fully refined, the process and equipment developed has already demonstrated economic viability for this application, and industry implementation is well under way. We have sold and installed our first production machine for ultrasonic polishing. Perhaps more surprisingly, this first installation was not at Kennametal itself but at a company called Elizabeth Carbide Die Company, one of their tool suppliers, with only 120 employees.

Other companies both large and small but with different comparable applications have been identified and contacted, and trials are in progress to apply the technique to their requirements.

In addition to improving surface roughness and uniformly removing undesirable surface layers such as EDM recast, tests have established the ability of the new process to induce residual compressive stresses, a potentially very important capability for highly stressed aircraft engine components.

Within less than 3 years, the viability of an important new manufacturing process with broad applications has clearly been established, and the process of commercialization has evolved to a level where second- and third-tier suppliers can put it to use. Our company provides early users and potential users with an eager supplier able to motivate, evaluate, try out, and support implementation at appropriate user sites.

We expect a sales volume of equipment of $2 million per year within 2 years, with growth at a minimum of 25 percent a year and hopefully much higher. Of course, a much greater value comes to those who acquire and use the new process and equipment and those who buy their products.

Polishing a 1-square-inch compacting tool or an injection mold requires about 4 to 6 hours of the most skilled tool maker's time and carries with it the risk of destroying an expensive nearly finished work piece. This project has demonstrated that for appropriate applications, this technique will eliminate 75 percent of that work, with the risk of scrap almost completely eliminated.

Even if the process finds no applications beyond polishing precision die and mold cavities, thousands of such cavities are manufactured annually within the U.S. industrial base. Within five years, the savings to the U.S. economy resulting from this $280,000 MANTECH contract could easily reach $100 million. This leverage is, I believe, one of the most attractive benefits of the MANTECH machine tool initiative.

I am not aware of any new process with comparable impact having been advanced as far as this one has within a comparable time period or budget. I am grateful that this project has provided us all with an opportunity to see how positive the U.S. Air Force machine tool initiative program can be for machine tool builders and users in the defense industrial base and throughout the U.S. economy in general.

Extrude Hone was recently awarded a program under the Air Force's machine tool sensor Improvements program to develop and demonstrate the use of a capacitance sensor system as a high-speed, high-precision, noncontact probe and a capacitive array for dimensional measurement of complex shapes and contours either on a machine tool or on an automated inspection cell. This effort will build on the results of a small subtask we did in an IMIP program directed by Garrett.

Another machine tool company that received a Phase I contract of approximately $380,000 has also had a very successful result. The project proposed development of a high-speed, highly stable machine tool spindle that would have the capability to greatly increase the metal removal rates of new, high-technology metal alloys, composites, and other materials. The production spindle—the Phase I test using aluminum alloys showed a potential for a production spindle that could increase metal removal rates as much as seven times. In production this would result in tremendous cost savings.

These projects, which involve a relatively small amount of DOD MANTECH funds, are examples of the benefits that could be realized on many other machine tool proposals if additional MAN-

TECH funding were available. And that leads me to some recommendations.

My first recommendation is an expanded machine tool industry thrust area. President Reagan determined that deterioration of the U.S. machine tool industry is a national problem which the Air Force alone cannot solve. A joint effort should bring together the Army, Navy, Air Force, DARPA, and the National Center for Manufacturing Sciences, or NCMS, to focus on this dilemma. A lead service should be designated, guided by a steering committee, chaired by OSD, similar to the existing structure for management of title III of the Defense Production Act. This Steering Committee could coordinate the program among the services, DARPA, NCMS, and others, and also assure that there is no duplication of effort.

Periodic conferences with industry should be held to ensure that the machine tool technology developed by this coordinated program is responsive to industry needs and is the type of technology that will be quickly applied to the production of qualitatively superior defense products with reduced manufacturing costs and analogous benefits to the nondefense sector.

An appropriate program would, in my view, draw into the industry and help support 200 advanced technical-degreed development-oriented personnel. That would be one person for more than half of the industry's 352 firms. If integrated into the structure of their firms, these advanced technologists would become resident technical counselors to other company personnel who are responsible for technical activities, enhancing the scientific value added by the firm. Within less than a decade, the technical content of the industry's products and services and the competitiveness of the U.S. industrial base it serves as technology providers would be significantly improved.

The development efforts should culminate in establishing a prototype capable of demonstrating the resultant technology development to potential users. The developer should agree to maintain, improve, or replace this prototype and make it available to demonstrate to potential U.S. industrial base users. This includes maintaining personnel capable of demonstrating it and, where appropriate, applying it to suitable applications of interested users.

These are all services that are easily and routinely provided by machine tool builders.

Project size should be large enough to accomplish something meaningful, yet small enough to be managed by the typical machine tool builder—a 1- to 3-year project of $250,000 to $750,000 magnitude seems appropriate.

To encourage small contractors and vendors such as machine tool builders to participate in the DOD Manufacturing Technology Program, an expedited contracting procedure such a task-ordering contract should be used to facilitate the rapid obligation of funds and the rapid implementation of newly developed manufacturing technology.

Integration of equipment suppliers within contractor teams would substantially expand MANTECH implementation in general. And that is my second recommendation.

The essence of manufacturing technology is the application of new scientific knowledge to the everyday task of making things.

Considering the current reality of reduced defense budgets and the probability that these budgets will not substantially increase in the near future, all defense programs must be evaluated and focused to get the biggest bang for the buck.

This should apply to the DOD MANTECH program as well. I recommend that the MANTECH program give primary focus and funding to projects and thrust areas that will produce tangible results, ones that in the near term ring the cash register with savings in the manufacture of defense products. This requires that the technology developed be broadly implemented where appropriate in the actual production of weapons systems.

Just as my company has been able to rapidly implement technology that it has developed under its MANTECH projects into the U.S. industrial base, integrating equipment and technology suppliers as significant partners in MANTECH project teams can dramatically expand the implementation of the developed technology. These organizations have the capabilities, the contacts and the incentives to transition these new methods efficiently throughout the industrial base.

To ensure rapid application of the technology that is developed, I recommend a teaming concept be used. Programs should be structured to utilize balanced teams of users, research centers, and implementers.

The users are the weapon system suppliers, Government prime contractors or others, who provide the focus for the technology under development, who define the requirements and utilize the resultant new method or tools. It is their savings translated into improved value or performance of DOD products that provides the near term payback for MANTECH investments.

There are a growing number of manufacturing technology research centers, such as the Nontraditional Manufacturing Research Center at the University of Nebraska at Lincoln or the U.S. Navy Center of Excellent in Metalworking Technology in Johnstown, PA, two organizations that we have worked with with great satisfaction, who are dedicated to identifying and researching the implications of new scientific knowledge to the field of manufacturing.

The third team members are the implementers. Kenneth Keller from the Council on Foreign Relations is one of a number of economists who have identified the traditional American separation of its scientific and industrial communities as a handicap to U.S. international competitiveness. Machine tool builders and other suppliers of industrial technology and equipment provide the much-needed link between the technology research centers and the industrial users. This teaming would ensure rapid technology transfer and would smooth and expedite the process of application and commercialization.

The formation of these teams can be accomplished through events such as MTAG and other DOD conferences and particularly through organizations such as the National Center for Manufacturing Sciences.

I urge that MANTECH maintain its current DOD management structure. From 1947 into the late 1970's, the DOD MANTECH budget was funded from a DOD procurement account. The justifica-

tion for this was its proven track record to reduce procurement costs. The orientation of the program through its management and interface with industry was with manufacturing personnel—vice presidents of manufacturing not vice presidents of research and development. The thrust of MANTECH was to solve manufacturing problems rather than to accomplish research. The objective was to bridge the gap between proven laboratory research and factory floor application.

I understand there is a possibility that the OSD and service management of the program may be shifted from the industrial resources industrial base out of the DOD organization structure to DDR&E. In my opinion, such a shift would destroy the historical justification for the MANTECH program. The program would lose its unique purpose and identity if it were shifted, and from an industry perspective, I strongly recommend this management change not be made.

Finally, stability of funding. This is essential in the MANTECH program because the majority of the projects involve multi-year funding and an industry commitment of critical resources. Very large changes in the annual DOD MANTECH budget, such as reducing $312 million in fiscal year 1991 to $96.9 million in fiscal year 1992, pose a risk to industry and serve as a disincentive to investment and commitment of corporate resources to projects that could be delayed or canceled the following year.

In conclusion, virtually everyone recognizes that it will be necessary to reduce or eliminate many defense programs as a result of major reductions in the defense budget. However, the DOD Manufacturing Technology Program has demonstrated for over 40 years that it is a proven money saver in the reduction of manufacturing costs and has the potential for even greater savings and manufacturing improvements in the future. It, therefore, appears logical that programs that have proven that they can reduce defense manufacturing costs and increase manufacturing productivity should be increased, not decreased during periods of reduced defense spending.

Senate Armed Services Committee Chairman, Sam Nunn, is quoted in the March 25th, 1991, issue of "Aviation Week" as vowing to press the issue of using technology to lower the cost of weapon systems. At a hearing on Air Force, Army, and Navy budget proposals, Nunn said he wanted to channel technology into more efficient manufacturing and quality control. Senator Nunn advised the service Secretaries that "technology must not be used simply for sophistication but for efficiency, effectiveness, and maintainability. Military planners'," he said, "tendency to reach for the highest levels of sophistication can get completely out of whack." In this quote Chairman Nunn has addressed the very essence and purpose of the MANTECH program.

The DOD MANTECH program has made significant contributions to the advancement of manufacturing technology over the years. These accomplishments have greatly reduced weapon systems costs and improved the quality and responsiveness of the country's industrial base. They have also made possible the production of many of the high-technology weapons that were so successfully employed in the recent Persian Gulf conflict.

However, I believe we have only scratched the surface of the potential of the MANTECH program. With proper organization and management, consistent high-level DOD support, and a consistent and adequate level of funding, this program can make a major contribution to reversing the deterioration of the U.S. defense industrial base. MANTECH has the potential to help restore the United States to a first-rate industrial power with all that that implies to national security and economic prosperity.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Rhoades follows:]

PREPARED STATEMENT BY LAWRENCE J. RHOADES, PRESIDENT EXTRUDE HONE CORPORATION

I. INTRODUCTION

Thank you, Mr. Chairman, for inviting me to testify before your subcommittee on a program that I believe is of great importance to our defense industrial base.

I am Larry J. Rhoades, President of the Extrude Hone Corporation, located in Irwin, Pennsylvania. Extrude Hone began operations in 1966. We are classified as a small business with under 150 people. We develop and implement new manufacturing processes for non-traditional machining, finishing and measurement. Although our most current technologies are provided only to our U.S. customer base, more than half of our equipment sales are to foreign manufacturers supported by six company-owned technical centers located worldwide. This gives us a perspective on manufacturing technologies and especially the implementation of these technologies in large and small manufacturing operations in industries ranging from turbine engines to sewing machines in countries from Germany to Jamaica. We manufacture equipment and consumables as well as offer subcontract machining using our specialized processes.

My company has been involved with the Department of Defense (DOD) Manufacturing Technology Program (MANTECH) for many years, and later I will describe the results of recent MANTECH projects that my company has completed. First, I think it would be of value to take a "big picture" look at the MANTECH program and review its background and history. This should be helpful in evaluating the program and determining its future direction.

II. BACKGROUND—HISTORY OF DOD MANTECH PROGRAM

The DOD Manufacturing Technology Program was started in 1947 by the Air Force. The total funding for Air Force MANTECH projects over the past 40 years has amounted to approximately $1.2 billion. Approximately 70 percent of the Air Force projects have been successful and have shown a genuine return on investment of more than 5 to 1. The Army, Navy and Defense Logistic Agency (DLA) did not start a formal manufacturing technology program until later. However, they have a history of many significant accomplishments and have realized approximately the same return on investment as the Air Force.

The objective of the MANTECH program is to develop and improve manufacturing technologies that will provide major increases in the productivity, quality, competitiveness and responsiveness of the U.S. defense industrial base. The majority of these new manufacturing technologies are directly transferable to the Nation's non-defense manufacturing industries and will therefore significantly contribute in the drive to improve U.S. international competitiveness.

The primary focus of the program is to transition the results of the billions of dollars that are spent on research and development in this country to direct application on the factory floor. It concentrates on generic manufacturing problems in all manufacturing industry sectors with emphasis on process technology that offers the potential to increase manufacturing productivity. A major portion of the program is conducted by contracts with prime contractors, subcontractors, vendors, universities and research institutions to assure the broadest possible base of development. MANTECH projects are also conducted in the arsenals, shipyards and air logistic centers.

MANTECH has historically shown it can deliver tangible results and significant cost savings in the manufacture of defense weapon systems. For this reason, it has survived many administrations and numerous Department of Defense budget cutting exercises over the years.

There are many MANTECH success stories. The most significant was the development of numerically controlled machine tools. This one successful project has saved the Department of Defense billions of dollars in metal removal costs and made possible the manufacture of many of our most advanced weapon systems. This technology was transferred to the Nation's non-defense manufacturing industries and basically revolutionized the manufacturing process in this country and the rest of the world. Other significant accomplishments of the MANTECH program include:

— Development of the first automated equipment for manufacturing and utilization of new generations of composite materials.

— The first implementation of flexible automation in U.S. factories.

— Development of an advanced non-destructive inspection technique for turbine engine components which has saved the Department of Defense more than a billion dollars to date.

— There are many more examples involving cast structures, lasers, electronics, munitions, and inertia welding that have resulted in significant cost savings, improved quality and weight reductions when applied to various air craft, helicopters and other weapon systems.

The DOD Manufacturing Technology Program has been the focus of many studies. All of the studies over the years have many points in common. They all conclude that the DOD MANTECH program is a key mechanism for strengthening the U.S. defense industrial base and reducing weapon system procurement costs. As a result of one study, the Defense Science Board recommended in 1980 that the MANTECH program be funded at a level of 1 percent of the annual DOD procurement budget. At that time, this recommendation would have resulted in an annual MANTECH budget of approximately $1 billion. The projected fiscal year 1992 MANTECH budget of $96.9 million will represent approximately 30.15 percent 1of the fiscal year 1992 DOD procurement budget of $63.4 billion. This small fraction of 1 percent for productivity improvement is not adequate to accomplish the objectives of this program and, in fact, will result in many times this figure being wasted through sub-optimal manufacturing methods.

III. CURRENT STATUS OF U.S. INDUSTRIAL BASE

The U.S. manufacturing base has experienced alarming deterioration during the past decade, and many critically important weapon systems have become dependent on foreign sources for critical components and supplies of materials. As stated in a recent issue of Foreign Affairs, "The Department of Defense has reported that the lead in developing one-quarter of the technologies most essential to American industry is held by non-U.S. firms, and a growing proportion of the products and components needed for defense come from abroad." This problem quickly became apparent even in the short Persian Gulf operation. According to a news article I recently read, a senior administration official was quoted as saying, "We were sweating bullets over it and the military was sweating bullets too." Is it really necessary to subject our military forces to these high level risks?

It is now widely recognized that the economic health and national security of a nation are determined by the strength of its manufacturing base. The long term viability of a country's manufacturing industries and critical technologies is dependent upon the health of its machine tool industry. In the October 1990 DOD Critical Industries Planning Report to Congress on the Defense Industrial Base, machine tools are the most frequently identified equipment essential to the support of the top eight critical defense technologies. Our Nation cannot maintain its economic and military position as a world power if it is dependent on foreign sources for the "tools" of manufacturing.

IV. CURRENT STATUS OF U.S. MACHINE INDUSTRY

The DOD Manufacturing Technology Program is especially important to the U.S. machine tool industry, for it has been particularly hard hit during the past decade. Although there are some larger companies (i.e., annual sales exceeding $100 million), the industry is composed of primarily small companies that do not have the financial resources (especially considering their current economic condition) necessary to fund the urgently needed research and development. The need is not only to improve the manufacturing technology to make machine tools, but more importantly to advance their role as the developers and implementers of the process technologies performed on the equipment. By producing, installing and supporting this equipment throughout the defense industrial base, these small technology-focused machine tool builders have the potential to be the most effective "carriers of technology" to transition new process knowledge to the factory floor.

The typical U.S. machine tool builder has fewer than 100 employees—actually 62 according to the NMTBA—The Association for Manufacturing Technology—with a significantly lower number of advanced degree manufacturing technology personnel than that of our chief foreign competitors. There are 352 machine tool builders in the United States with more than 20 employees. Total industry employment is 72,500 (33 percent less than in 1980). In the 1980s, the U.S. position as the world's leading producer and exporter of machine tools changed dramatically so that by 1986 the number of machine tools built in Japan alone was almost 10 times that of the United States: 39,000 versus 4,000. Today, the United States is ranked sixth in machine tool production (behind the Soviet Union, Japan, Germany, Switzerland, and Italy).

Recognizing this problem, and also recognizing the necessity of a viable U.S. machine tool industry to our national security, on December 16, 1986, President Reagan took action under authority of section 232 of the trade laws to help the U.S. machine tool industry help itself. He directed the Department of Defense to execute a Domestic Action Plan to assist in the revitalization of the machine tool industry. As a result of the Presidential directive, a major "thrust area" for machine tool development was established within the Air Force Manufacturing Technology Program.

To implement this Machine Tool Initiative, the Air Force published a Program Research and Development Announcement (PRDA) that requested proposals for the development and production of new and improved "next generation" machine tools and manufacturing processes and equipment. Industry responded with 85 proposals. However, due to limited funding, the first phase of only 10 proposals was selected to be put on contract. My company was one of the companies selected.

V. EXTRUDE HONE INVOLVEMENT IN MANTECH PROGRAMS

Our involvement with MANTECH prior to this initiative began as a subcontractor to Pratt & Whitney to develop methods and equipment to produce low cost, high accuracy graphite EDM electrodes for machining complex airfoil shapes in advanced materials. The effort yielded a new level of precision and flexibility to these machining techniques through substantial advances in machine design. Our role went beyond that of a supplier of equipment. Pratt & Whitney sought our active participation as a developer of new technology. As an equipment builder, we have been uniquely able to responsibly transfer the developed technology to other potential users. For example, GE is now actively considering the incorporation of the developed technology in an Industrial Modernization Incentives Program (IMIP) at their airfoil production facility. A special capability of the role we fulfilled as an equipment builder with a tight technology focus and links throughout the industrial base has been the application of this technology to analogous, but not so obvious, applications in non-defense industries such as plastic injection molds and pharmaceutical dies.

In 1988, we received the first contract award under the DOD/Air Force's Machine Tool Initiative. The objective of our project was the development of a new method for finishing surfaces and edges of complex high precision cavities by ultrasonic abrasion using a self forming abradable "tool." The initial focus of the effort has been directed to polishing the compacting tools that form the contoured faces of carbide cutting tool inserts. Our user industry partner for that application was Kennametal.

Although yet to be fully refined, the process and equipment developed has already demonstrated economic viability for this application and industry implementation is well underway. We have sold and installed our first production machine for ultrasonic polishing. Perhaps more surprisingly, this first installation was not at Kennametal itself, but at Elizabeth Carbide Die Co., one of their tool suppliers with only 120 employees.

Other companies with different but comparable applications have been identified and contacted, and trials are in progress to apply the technique to their requirements. Perhaps the greatest near term success is expected in the polishing of plastic injection molds. These molds are made of tool steel and are often larger in area and deeper than the cavities in the carbide cutting insert molds, yet appear to be excellent applications for the process. We have a high confidence level that before the project is complete at least one, and possibly several, injection mold makers will order equipment developed under this program for ultrasonic polishing.

In addition to improving surface roughness and uniformly removing undesirable surface layers such as EDM recast, tests have established the ability of the new process to induce residual compressive stresses—a potentially very important capability for highly stressed aircraft engine components.

The viability of an important new manufacturing process with broad applications has clearly been established, and the process of commercialization has evolved to a level where second and third tier suppliers can put it to use. Our company provides early users and potential users with an eager supplier able to motivate, evaluate, try out and support implementation at appropriate user sites.

We expect a potential sales volume of equipment of $2 million per year within 2 years with growth at a minimum of 25 percent per year (perhaps much higher). Of course, a much greater value comes to those who acquire and use the new process and equipment and those who buy their products. Polishing a 1 square inch compacting tool (or an injection mold) requires about 4 to 6 hours of the most skilled tool maker's time and carries with it the risk of destroying an expensive, nearly finished workpiece. This project has demonstrated that for appropriate applications, this technique will eliminate 75 percent of that work with the risk of scrap almost completely eliminated.

Even if the process finds no applications beyond polishing precision die and mold cavities, thousands of such cavities are manufactured annually within the U.S. industrial base. Within 5 years, the savings to the U.S. economy resulting from this $280,000 MANTECH contract could easily reach $100 million. This leverage is, I believe, one of the most attractive benefits of the MANTECH Machine Tool Initiative.

I am not aware of any new process with comparable impact having been advanced as far as this one has within a comparable time period or budget. I am grateful that this project has provided us all with an opportunity to see how positive the U.S. Air Force's Machine Tool Initiative Program can be for machine tool builders and users in the defense industrial base and throughout the U.S. economy in general.

Extrude Hone was also recently awarded a program under the Air Force's Machine Tool Sensor Improvements PRDA to develop and demonstrate the use of a capacitance sensor system including capacitive non-contact analog probe and a capacitive array dimensional measurement system to check the dimensions of complex shapes and contours on a machine tool or in an automated inspection cell. This effort will build on the results of an IMIP project directed by Garrett.

Another machine tool company that received a Phase I contract of approximately $380,000 has also had very successful results. This project proposed development of a high-speed, highly stable machine tool spindle that would have the capability to greatly increase the metal removal rates of new high technology metal alloys, composites and other materials. The Phase I tests using aluminum alloys showed a potential for a production spindle that could increase metal removal rates as much as seven times. In production, this would result in tremendous cost savings.

These projects, which involve a relatively small amount of DOD MANTECH funds, are examples of the benefits that could be realized on many other machine tool proposals if additional MANTECH funding were available.

VI. RECOMMENDATIONS

A. *Machine Tool Industry "Thrust Area"*

President Reagan determined that deterioration of the U.S. machine tool industry is a national problem which the Air Force alone cannot solve. A joint effort should bring together the Army, Navy, Air Force, the Defense Advanced Research Project Agency (DARPA) and the National Center for Manufacturing Sciences (NCMS) to focus on this dilemma. A lead service should be designated and guided by a Steering Committee chaired by the Office of Secretary of Defense (OSD) (similar to the existing structure for management of Title III of the Defense Production Act). This Steering Committee could coordinate the program among the services, DARPA, NCMS, etc., and also assure that there is no duplication of effort. Periodic conferences with industry should be held to ensure that the machine tool technology developed by this coordinated program is responsive to industry needs and is the type of technology that will be quickly applied to the production of qualitatively superior defense products with reduced manufacturing costs and the analogous benefits to the non-defense sector.

An appropriate program would draw in and help support 200 advanced technical degreed development-oriented personnel (one person for more than half of the industry's 352 firms) into the industry. Integrated into the structure of their firms, these "advance technologists" would become resident technical counselors to other company personnel who are responsible for technical activities, enhancing the scientific value added by the firm. Within less than a decade, the technical content of the industry's products and services, and the competitiveness of the U.S. industrial base it serves as technology providers, would be significantly improved.

The development effort should culminate into establishing a prototype capable of demonstrating the resultant technology development to potential users. The developer should agree to maintain, improve or replace this prototype and make it available to demonstrate to potential U.S. industrial base users. This includes maintaining personnel capable of demonstrating it and where appropriate applying it to suitable applications of interested users.

Project size should be large enough to accomplish something meaningful, yet small enough to be managed by the typical machine tool builder—a 1 to 3 year project of $250,000 to $750,000 magnitude seems appropriate.

To encourage small contractors and vendors (such as machine tool builders) to participate in the DOD Manufacturing Technology Program, an expedited contracting procedure (such as Task Ordering Contracts) should be used to facilitate rapid obligation of funds and rapid implementation of newly developed manufacturing technology.

B. Expanding MANTECH Implementation Through Integration of Equipment Suppliers in Contractor Teams

The essence of manufacturing technology is the application of new scientific technology to the everyday task of making things. Considering the current reality of reduced defense budgets and the probability that these budgets will not substantially increase in the near future, all defense programs must be evaluated and focused to get the "biggest bang for the buck." This should apply to the DOD MANTECH program as well. I recommend that the MANTECH program give primary focus and funding to projects and "thrust areas" that will produce tangible results—ones that in the near term "ring the cash register" with savings in the manufacture of defense products. This requires that the technology developed be broadly implemented where appropriate in the actual production of weapon systems.

Just as my company has been able to rapidly implement technology it has developed under its MANTECH projects into the U.S. industrial base, integrating equipment and technology suppliers as significant partners in MANTECH project teams can dramatically expand the implementation of the developed technology. These organizations have the capabilities, contacts and incentives to transition these new methods efficiently through the industrial base. To ensure rapid application of the technology that is developed, I recommend a teaming concept be used. Programs should be structured to utilize balanced teams of users, research centers and implementers.

Users—Weapon system suppliers (government prime contractor or other) are the users who provide the focus for the technology under development, define the requirements and utilize the resultant new methods or tools. It is their savings translated to improved value or performance of DOD products that provides the near-term payback for MANTECH investment.

Research Centers—There are a growing number of manufacturing technology research centers (such as the Nontraditional Manufacturing Research Center at the University of Nebraska Lincoln or the U.S. Navy Center of Excellence in Metalworking Technology in Johnstown, Pennsylvania) dedicated to identifying and researching the implications of new scientific knowledge to the field of manufacturing.

Implementers—Kenneth Keller from the Council on Foreign Relations is one of a number of economists who have identified the traditional American separation of scientific and industrial communities as a handicap to U.S. international competitiveness. Machine tool builders and other suppliers of industrial technology and equipment provide the much needed link between the technology research centers and industrial users. This teaming would ensure rapid technology transfer, and would smooth and expedite the process of application and commercialization.

The formation of these teams can be accomplished through vents such as the Manufacturing Technology Advisory Group (MTAG) and other DOD conferences and particularly through organizations such as the National Center for Manufacturing Sciences.

C. *Maintain Current DOD Management Structure*

From 1947 into the late 1970s, the DOD MANTECH budget was funded from the DOD procurement account. The justification for this was its proven track record to reduce procurement costs. The orientation of the program throughout its management and interface with industry was with manufacturing personnel (i.e., Vice Presidents of Manufacturing not Vice Presidents of Research and Development). The trust of MANTECH was to solve manufacturing problems rather that to accomplish research. The objective was to bridge the gap between proven laboratory research and factory floor application.

I understand there is a possibility that the OSD and service management of the program may be shifted from the Industrial Resources-Industrial Base side of the DOD organization structure to the offices of the Director, Defense Research and Engineering (DDR&E). In my opinion, such a shift would destroy the historical justification for the MANTECH program. The program would lose its unique purpose and identity if it were shifted to DDR&E. From an industry perspective, I strongly recommend this management change not be made.

D. *Stability of Funding*

Stability of funding is essential in the MANTECH program because the majority of the projects involve multi-year funding and an industry commitment of critical resources. Very large changes in the annual DOD MANTECH budget, such as reducing $312 million in fiscal year 1991 to $96.9 million in fiscal year 1992, pose a risk to industry, and serve as a disincentive to investment and commitment of corporate resources to projects that could be delayed or canceled the following year. The Defense Logistics Agency, for example, has several very important multi-year programs that are subject to expensive delays or cancellation as a result of their MANTECH budget being "zeroed out" for fiscal year 1992 in the administration's budget submission.

VII. CONCLUSION

Virtually everyone recognizes that it will be necessary to reduce or eliminate many defense programs as a result of major reductions in the defense budget. However, the DOD Manufacturing Technology Program has demonstrated for over 40 years that it is a proven money saver in the reduction of manufacturing costs and has the potential for even greater savings and manufacturing improvements in the future. It, therefore, appears logical that programs that have proven that they can reduce defense manufacturing costs and increase manufacturing productivity should be increased, not decreased, during periods of reduced defense spending!

Senate Armed Services Committee Chairman Sam Nunn (D-GA) is quoted in the March 25, 1991 issue of Aviation Week as vowing to "press the issue of using technology to lower the cost of weapon systems. At a hearing on Air Force, Army and Navy budget proposals, Nunn said he wants to channel technology into more efficient manufacturing and quality control. Nunn advised the service Secretaries that technology must not be used simply for sophistication, but for 'efficiency, effectiveness and maintainability.' Military planners' tendency to reach for the highest levels of sophistication can get 'completely out of whack,' Nunn said." In this quote, Chairman Nunn has addressed the very essence and purpose of the MANTECH program.

The DOD MANTECH program has made significant contributions to the advancement of manufacturing technology over the years. These accomplishments have greatly reduced weapon system costs, and improved the quality and responsiveness of this country's industrial base. They have also made possible the production of many of the high technology weapons that were so successfully employed in the recent Persian Gulf conflict.

However, I believe we have only scratched the surface of the potential of the MANTECH program. With proper organization and management, consistent high level DOD support, and a consistent and adequate level of funding, this program can make a major contribution to reversing the deterioration of the U.S. defense industrial base. MANTECH has the potential to help restore the United States to a first rate industrial power with all that it implies to national security and economic prosperity.

Senator BINGAMAN. Thank you very much. Are we spending our MANTECH dollars in a way that will give us the greatest impact? As a general matter, my impression is that we spend them on very discrete projects being pursued by defense contractors to upgrade their manufacturing. We are spending very little, if anything, in the dissemination of these new manufacturing processes across industry. Now, maybe my impression is wrong. If it is, correct me. What is your reaction to the question of whether those dollars are being spent in the most beneficial way at the present time?

Mr. RHOADES. I have been involved in the development and the evolution of new manufacturing processes for 20-some years now,

and have watched these processes grow. I think that having an initial application within a DOD prime, particularly in a weapon systems application, is an appropriate beginning to the evolution of a new process. Generally they are faced with nonnegotiable design requirements or they would not be considering the use of new processes in many cases in the first place. And they probably have to make these products out of materials that are advanced and difficult to machine so that conventional processes are not capable of machining them. So, consequently, these early applications provide a focus and a real direction to the development of a new process.

I think the critical element, however, is to integrate technology implementers into the project at the very beginning and as a meaningful members of that development team. Small companies with a tight technology focus have the privilege—certainly machine tool builders do, even if they are not very clever—of walking through a number of manufacturers in the United States and throughout the world who manufacture the same kinds of things. And they get to watch people use and misuse these processes. And they aggregate responsibly that collective experience and provide that as part of their business and services with their products.

So by integrating them into that team, they are able to learn lessons and find analogies that are not at all obvious to an end-user whose specific focus is on the manufacture of aircraft or artillery or missiles, who has all the distractions and schedule pressures that producing the end products provide. But the technology company—the technology provider, like a machine tool builder—is not distracted by all that other stuff. All he is concerned with is his own narrow little technology, and so he is able to learn lessons and to delve into the details, so that when he is finished with the development effort he can apply that learned technology into a whole range of applications. And he has the incentives to do that as well.

So I think that that addition, that mixing in on most MANTECH programs of technology providers as substantial partners, is really the key path to getting the implementation, especially at the second- and third-tier subcontractor levels.

Senator BINGAMAN. Let me ask about your specific circumstance. As I understand your testimony, you have indicated that the process that you have been able to develop for polishing precision die and mold cavities could, within 5 years, save the U.S. economy $100 million as a result of a $280,000 MANTECH contract.

Mr. RHOADES. That is right.

Senator BINGAMAN. What do you see that DOD needs to do to ensure that that happens?

Mr. RHOADES. I do not know that DOD needs to do anything else. I think that the investment they made was in the early end of a process development effort, in the highest-risk early end of that. And they encouraged us to take that step, and I think that there is sufficient viability that has been demonstrated at this point that we and our potential customers will carry out that implementation without further investment by the taxpayer.

But the critical step was to get that process started. And given a set of choices, I would encourage more investments and more early efforts at new process development to bring them to the point of initial viability demonstration.

So for that process, I think that the Department of Defense's role is complete. It is our job now to implement that technology where it is appropriate and throughout the U.S. industrial base.

Senator BINGAMAN. Are you familiar with these manufacturing extension programs that the State of Pennsylvania has in place?

Mr. RHOADES. Indeed, I have been very active in the program in southwestern Pennsylvania, and it is really quite a good program.

Senator BINGAMAN. Do you see a tie or a way in which those manufacturing extension efforts that Pennsylvania has can be used to disseminate technologies developed through the MANTECH program? Am I trying to make a fit that does not work?

Mr. RHOADES. No, I think that that is a very sensible effort. I am aware peripherally of the PRISM effort that the U.S. Air Force is doing to explore the use of extension services or industrial resources centers as a method of helping to use these organizations to disseminate that technology. And I think that that is a very appropriate effort.

I think a linkage of local technology and industrial resource center efforts into assisting in the referral and identification of opportunities for these newer technologies is quite useful. Those organizations are also particularly useful at bringing generic technology to the attention of especially smaller manufacturing operations, who have been so busy with keeping their nose to the grindstone that they have not been keeping current on recent developments that could affect their manufacturing productivity.

So I highly support that effort. I think that is a very appropriate one, and I think that there must be ways to integrate the efforts together.

Senator BINGAMAN. Are there a substantial number of small manufacturers in the same type of industry that can be encouraged to come together as consortia and take advantage of MANTECH funds to pursue upgrading of technology? I gather there has not been that much use of MANTECH dollars to support consortia of manufacturers in the past.

Mr. RHOADES. I have been active in a number of efforts at this, the principal one being the National Center for Manufacturing Sciences, which I have been very active in from its earliest stages. And I think that that effort is worthwhile. The concept is a great concept, and I think that there are ways to fit those efforts together.

The developed technology—developed in a group effort, even through existing MANTECH programs, if consortia of technology providers are brought together or a group of a number of technology providers are brought together, each with their own technology specialty into a MANTECH program done by a prime, I think that is another way to bring the smaller companies together and to develop technology that is learned from that, together with its not-so-obvious analogies, so we can then have these companies installing that technology into other potential users.

So I think that there are ways to do that. Consortia are difficult to evolve in a nation with a cultural history of the maverick. So sometimes there are some cultural changes that are required in that, and I think we have to be patient with these efforts.

Senator BINGAMAN. Let me ask you the general question that I asked both Dr. White and Mr. McMillan about the appropriateness of DOD's efforts in manufacturing being combined with the Department of Commerce's efforts. Is there really a justification for continuing to go down two tracks where we have MANTECH and a certain kind of subcontractor or firm gets to take advantage of that kind of a program? Others are shut out of that.

For example, semiconductor manufacturing firms, which I referred to earlier, do not do business with the Department of Defense. They do business with the semiconductor industry, and the semiconductor industry does business with the Department of Defense. In some cases, the semiconductor industry does not do business directly but does business with the systems manufacturer and then the systems manufacturer does business with the Department of Defense.

Does it make sense to say, the semiconductor equipment manufacturer should not be able to participate in a MANTECH program, because they do not do business directly with the Department of Defense?

Mr. RHOADES. We do not do much business with the Department of Defense. I do not know that that is a real concern. My company has had development projects funded by the State of Pennsylvania, by SBIR programs, through the Department of Energy, and through NASA. In fact, the largest development contract we have ever received, we recently received through our Irish subsidiary from the European Economic Commission for as much money as we have received collectively from all our Department of Defense efforts.

So I think in the field of manufacturing there is not so much exclusion from area to area. Certainly the DOD MANTECH program has been the major support in this country for the development of new manufacturing technology.

I think that there are—that there is much to be gained by coordinating the efforts of the MANTECH programs and the Department of Commerce's programs. The MANTECH effort implies that its principal objective in the initial focus of development efforts will normally be, and in all but a few cases would be, to reduce the cost of weapon systems as the initial focus of that process development.

I think the critical thing is to see that there is an evolution of the lessons learned—the technology developed in that effort into the economy in general in the United States. And so that is the link.

The Department of Commerce can choose focuses for the initial effort of its development programs that may be different from the production of weapon systems. But it seems appropriate that the MANTECH program be directed initially, principally, to the solution of defense weapon systems efforts, with a built in mechanism so that that effort sees its way into the factory floor of second- and third-tier suppliers and into other industries beyond the defense base.

Senator BINGAMAN. And is that built in mechanism in place?

Mr. RHOADES. I do not believe that that is in place nearly as well as it would be if there were a significantly larger role for the small,

technology-focused companies who provide machine tools or semiconductor manufacturing equipment, who provide the equipment, and along with it, the process technology that then is used by the end-users of that equipment in making the end products.

So I think that the critical link is to see that they are brought into that process in a more active way.

In the case of the U.S. machine tool industry, I think that that needs to be combined with a machine tool industry thrust area to help build the technology content and the technical competence within the industry up a step or two from its current average level.

Senator BINGAMAN. Let me ask just a final question about this Moore Specialty Tooling Company in Connecticut. I understand that they are in a very awkward situation where they have been prohibited from entertaining an infusion of cash or an investment by a foreign firm because of their doing business with the Department of Defense.

Could you explain what you know about that situation, its status, and whether this is a generic problem that this committee or the Congress needs to try to do something to remedy or if this was just a very weird situation?

Mr. RHOADES. I think the Moore case demonstrates two points, the first of which is that a small company like Moore has—because it is a machine tool builder and an excellent one—has enough importance to the Nation that it is in effect an effective tool of U.S. foreign policy or it is a concern for U.S. foreign policy and defense concerns.

The real issue with Moore Special Tool is the fact that, with Government encouragement, Moore has been an active exporter, Wayne Moore was—served on the Advisory Board of the Export/Import Bank, and Moore Special Tool is a very active exporter. Among its export markets are both Japan, which is its second largest market, and the PRC.

It encountered significant difficulties in getting export licenses to the PRC after it had established a substantial market there. So the export licensing scenario or environment for Moore Special Tool's products to the PRC changed fairly dramatically, so that it was taking on average 2 to 3 years to get an export license to sell its equipment to the PRC. Very few license applications were rejected. But it took that long to process the applications.

As a result it lost a significant portion of that market to the Swiss, who could deliver readily without that complication. And it had substantial inventory that it had built up to sell to that market. And that is really what I find most tragic about the Moore situation.

One of the—the fact of a foreign investor in Moore is really a separate issue, and I think it is largely moot at the moment. Both Moore and their potential investor, Fanuc, are first-class, world-class firms.

And the real thing that seems to be demonstrated to me there is the important nature of the machine tool industry as critical technologies. And if they are denied access to world markets, if they are denied the ability to seek capital from wherever they might, then there ought to be some sort of program, either research support to help make up for the revenues lost because they no longer

have a license to sell to significant markets in the world or some sort of capital available to them to help preserve that asset.

The real tragedy would be if a company as fine as Moore is—and I do not think there is a real risk of this—if that company were weakened as a result of these actions by the Government, then that result would be that the Nation would have lost a genuine national asset that is, on occasion—if the Government so decides—a useful mechanism for influencing foreign policy.

Senator BINGAMAN. All right. We have got other things we could go into, but I think I will stop with that. And I appreciate you coming to testify. Very, very interesting testimony.

Mr. RHOADES. Thank you.

Senator BINGAMAN. Thank you, and we will adjourn the hearing.

[Additional prepared statement submitted for the record follows:]

PREPARED STATEMENT BY LEO REDDY, PRESIDENT, NATIONAL COALITION FOR ADVANCED MANUFACTURING

STRATEGY FOR U.S. INDUSTRIAL STRENGTH

INTRODUCTION

Two central realities confronting the United States as it sets its national agenda and priorities. The first is that our resources are finite. The second is that we must manage those resources wisely.

The demands upon our finite resources often appear infinite. The rise of new centers of economic power strains our national capacity for industrial productivity, technological innovation, and capital investment. The Gulf war, the uncertain future of the Soviet Union, and the proliferation of weapons of mass destruction remind us of the continuing need to allocate significant resources to national defense. A host of social challenges require expenditures which presently appear beyond the reach of Federal, State, county, and municipal budgets combined.

Surely an optimum goal of public policy in the 1990s should be to manage our national resources with sufficient wisdom so that, before the end of the decade, the United States can meet its major challenges and obligations in all three areas—economic, military, and social—within the Nation's resource base and the bounds of sound fiscal management. Given America's impressive human and material resources, this goal is well within our grasp. It will, however, require ingenuity, flexibility, and new patterns of interaction among the holders of those resources, particularly industry, government, and academia.

A case in point is one of America's most vital resources, its industrial base, and particularly its manufacturing industries. It is especially important that this Senate committee view this resource as an integral component of national security. The U.S. defense industrial base is a subset of U.S. manufacturing as a whole. Very few "defense contractors" depend exclusively upon the Department of Defense for their business. The vast majority have substantial civilian manufacturing operations.

There are some firms, of course, who are wholly dependent upon Pentagon contracts, and some forms of production are needed exclusively for military needs. Yet the Nation's ability to produce the weapons and materiel needed for its defense policy requirements depends most critically upon a robust, responsive, and competitive national infrastructure for manufacturing. For this reason, this statement deals primarily with the Nation's overall manufacturing base.

ROLE OF MANUFACTURING

To provide some perspective, it is important to understand the role of manufacturing in the U.S. economy. A sanguine view for several years has been that manufacturing has been declining in importance and is being displaced by service industries. This view is misleading and potentially destructive.

Manufacturing has not become less important to the U.S. economy. It has remained steady at 19-23 percent of real (inflation-adjusted) GNP since 1947. Also, manufacturing productivity is significantly higher than service sector productivity. Goods, not services, account for roughly 85 percent of world trade. Many observers

are now looking to manufactured exports, not to service industries, to lead the country out of recession.

Finally, manufacturing industries account for about 90 percent of nongovernmental R&D funding and are acutely sensitive to innovative technology. They are the battleground on which most of the global technology race is being fought. The astute deployment of technology is vital to making high value-added products, which define a Nation's leadership in the world marketplace.

In any case, the distinction between manufacturing and service industries is growing less relevant and useful as a tool of analysis. As corporations move towards integrating traditional corporate functions in a total quality environment, the relationship between production and service functions within firms is becoming closer. In particular, high-technology industries generate more service-related jobs than do more basic products.

Moreover, many service and raw-materials producing jobs are tightly related to manufacturing. For example, in the late 1980s, the number of persons directly employed in manufacturing industries was 20 million on the average, while the number of persons employed in industries that support manufacturing was estimated at 20-30 million. The total manufacturing-linked employment was thus between 40-50 million, around 40 percent of the total national labor force.

Our leading overseas competitors have viewed manufacturing, not as a declining asset, but as the main engine of growth. They have understood that a Nation's financial strength and economic power turns essentially on its ability to produce high-quality, cost-effective products that are responsive to customer demand.

There is no serious question about the continued importance of manufacturing industries to the strength of the U.S. economy. There is much controversy, however, over the health of the manufacturing sector and its ability to meet the new challenge of competition both in domestic and international markets.

CHALLENGES TO U.S. MANUFACTURING

A welter of reports, hearings, legislation, and new organizations have appeared in recent years in response to a series of concerns over the state of U.S. manufacturing: a perceived loss of competitiveness, a "deindustrialization" of the economy, a "hollowing out" of U.S. industry, an "erosion" of America's industrial base, an excessive dependence upon overseas suppliers of critical defense components, etc.

Some of these analyses are unduly alarmist. As noted above, manufacturing as a whole continues to maintain a firm grip on its percentage of real GNP. Many sectors of U.S. manufacturing, even though they have lost some portion of the global market, remain strongly competitive, e.g., chemicals, aerospace, computer software, instrumentation, and advanced materials.

The prospects for a surge in manufactured exports are steadily improving, as the value of the dollar declines, foreign demand for manufactured goods is surging, and a growing number of U.S. firms, even medium-sized manufacturers, are becoming increasingly sophisticated in international business. Indeed, American manufactured exports rose nearly 10 percent in 1990.

In terms of manufacturing processes, several U.S. factories have state-of-the-art production facilities. Due to advances in automation and other labor-saving technologies, relatively high labor costs in the United States are less and less significant as a cost factor. The Manufacturing Studies Board recently reported that direct labor content in most U.S. manufacturing industries has dropped to 15 percent or less of production costs and in high-technology industries is increasingly less than 5 percent of production costs.

Moreover, declining interest rates combined with a restoration of consumer confidence following the Gulf war will lead to an upsurge in manufacturing activity in the United States. Since modern inventory control technology has helped firms to keep inventory levels low, this upsurge in demand will translate into new factory orders.

From a global perspective, it is not surprising that other industrialized nations are leading in individual product areas, especially given the internationalization of manufacturing. The United States cannot realistically expect to lead in every industry sector.

However, even though the alarmists may have overstated their case, there are serious reasons for concern over the longer-term prospects for U.S. manufacturing.

One is obviously the Nation's stubborn trade deficit which, despite recent signs of improvement and the advantage of an undervalued dollar, still remains seriously unbalanced at the $100 billion level. Another legitimate area of concern is the loss of market share. Although the United States cannot expect to predominate in every

industry, the *sheer magnitude* of the decline in market share commands our attention.

The September 24, 1990 issue of Fortune magazine, in a table compiled by Eduard Faltermayer, showed American-owned manufacturing companies losing a significant share of the domestic U.S. market between 1979 and 1989 in the following industries:

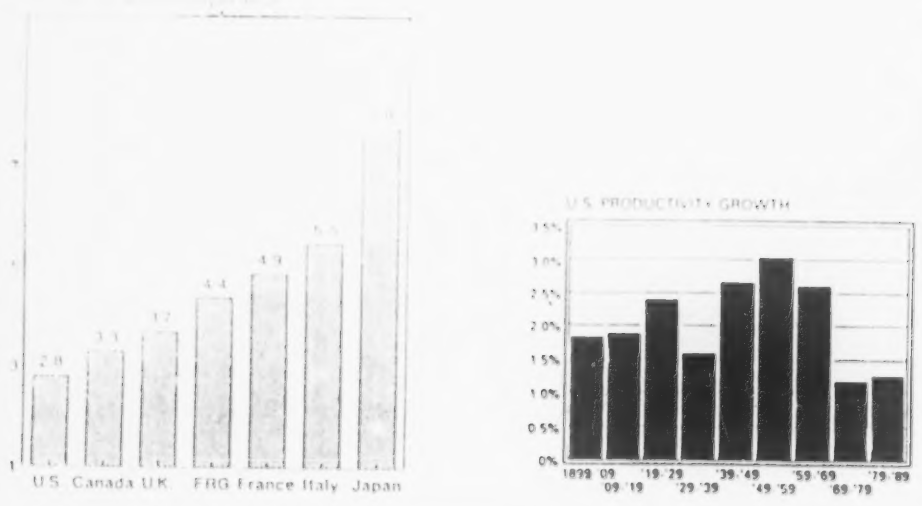
- High-tech: chemicals, aerospace, computers, drugs, telephone equipment, semiconductors, and machine tools.
- Other industries: food, drinks and tobacco, cars and light trucks, apparel, textiles, steel, paper and paperboard, industrial machinery, household furniture, household appliances, tires, nuts, bolts and washers, color TV, ball and roller bearings, and cement.

STRUCTURAL WEAKNESSES IN U.S. MANUFACTURING

More compelling than fluctuations in the business cycle, levels of consumer confidence or the temporary gain or loss of market share are the *structural* weaknesses within the U.S. manufacturing enterprise. These are the deep-seated flaws that, over time, sap the vigor and competitiveness of *all* manufacturing industries.

These are the problems that, if not corrected, create the greatest danger that the United States will gradually lose its economic leadership and become primarily a supplier of raw materials, low-cost labor, and low value-added products to more sophisticated industrial powers in Europe and Asia.

Productivity loss. In productivity, the 1989 United States output per hour in manufacturing increased by only 2 percent, a drop of about 60 percent from the peak gains achieved in 1983–84. This dismal performance left the United States behind all but 1 of 11 other industrial countries in productivity growth that year. Table I offers a view of the current comparative position of the United States in productivity, measured by productivity growth in output/hour, as well as historic trends in U.S. productivity growth.



Sources: U.S. Department of Labor, Bureau of Labor Statistics
Historical Statistics of the United States

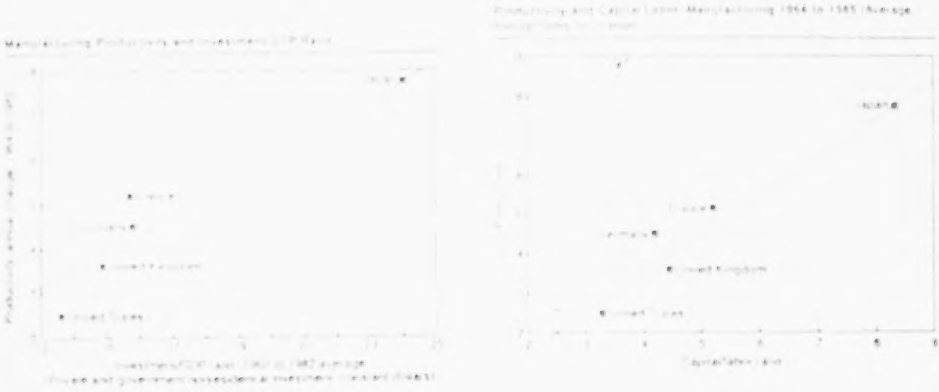
Capital investment: In the last 3 years, the proportion of Japan's Gross Domestic Product devoted to investment in manufacturing has risen sharply, increasing almost six times faster than the corresponding rate in the United States. In 1990, manufacturing investment in Japan comprised about 5.1 percent of its total GDP (in current dollars in yen) compared with 3.5 percent for the United States. One result is that the average age of industrial equipment in U.S. factories is nearly 11 years as compared with 7 years for Japan.

A close correlation exists between manufacturing productivity increases and capital investment. (See Table 2.) The fact that capital equipment purchases in the United States are now beginning to climb is a healthy sign, but higher rates will need to be sustained over several years to modernize equipment at all levels of the U.S. industrial base.

TABLE 2

THE BASIC EQUATION

PRODUCTIVITY GAIN = INVESTMENT + MODERNIZATION



Source: OECD, National Accounts of OECD Countries, 1987, vols. 1 and 2.

Tax Structure: One reason for the decline in capital investment is the absence of significant tax incentives. Indeed, current tax policies include disincentives to such investment. For example, with the repeal of the investment tax credit and other provisions in the Tax Reform Act of 1986, the effective tax rate for equipment rose from 10 percent to just under 40 percent. It is noteworthy that in the years following the TRA, Japanese investment in plant and equipment has skyrocketed while in the United States there has been little change. (See Table 3.)

TABLE 3

IN THE THREE YEARS FOLLOWING THE TRA, JAPANESE INVESTMENT IN P&E HAS SKYROCKETED WHILE IN THE U.S. THERE HAS BEEN LITTLE CHANGE

	U.S.			JAPAN		
Year	Investment in P&E ($B)	Annual Rate of Increase	Investment /GDP	Investment in P&E (trillion yen)	Annual Rate of Increase	Investment /GDP
1987	$146	11.0%	3.2%	10.4	5.5%	2.9%
1990	$192	4.7%	3.5%	21.5	17.4%	5.1%

Sources: U.S. Bureau of Census Plant and Equipment Survey PESVY (90) 2
Nihon Keizai Shumbun, September 22, 1990

In the unlikely event that the Congress agrees to the administration's proposal for a capital gains tax reduction, those reductions would not necessarily result in major increases in capital investment. Many of our overseas competitors have tax codes that favor factory modernization.

Cost of capital: Let us hope that the Federal Reserve Board's present effort to lower interest rates, relax accounting rules, and ameliorate reserve requirements will ease the perennial problem of capital availability. Even with these improvements, however, U.S. firms will still have difficulty gaining access to the long-term, "patient" capital needed to finance plant modernization. Especially with the decline of the venture capital market in the United States and the escalating costs of capital equipment, many firms are turning to overseas banks for development capital.

R&D Policy: Advanced manufacturing technologies have become so expensive to develop that even the largest companies have great difficulty financing these costs. Although the administration's proposed budget for fiscal year 1992 envisages a 13 percent overall increase in Federal R&D funding, it actually decreased funding for advanced manufacturing, which includes generic, precompetitive manufacturing process technologies. It should be noted that while Japanese R&D in manufacturing technologies concentrates two-thirds of its investment in process technologies and one-third in product technologies, the ratio in the United States is exactly the obverse.

Slow adoption of new process technologies: As a result of all the foregoing factors, U.S. manufacturers are significantly slower in applying advanced production technologies than their leading overseas competitors. One example is the rates of adoption of numerically-controlled (NC) machines, a basic manufacturing technology. Table 4 shows the United States behind other leading industrialized nations in the use of NC machines.

TABLE 4

THE U.S. IS LAGGING BEHIND IN THE ADOPTION OF AUTOMATION

- JAPAN IS WAY AHEAD IN ALL AREAS OF FLEXIBLE AUTOMATION
- INDUSTRIAL COUNTRIES IN EUROPE ARE ALSO PULLING AHEAD

	Percentage Share of NC-Machines		
Type of Machine	Milling Machines	Lathes	Total Metalcutting
Germany	26.5%	65.0%	69.1%
France	23.7%	91.0%	67.5%
Italy	90.0%	72.5%	85.0%
United Kingdom	N/A	76.7%	66.1%
Spain	N/A	N/A	50.0%
Japan	61.8%	80.0%	69.1%
United States	43.6%	94.5%	42.7%

Sources: Economic Commission for Europe, Annual Review of Engineering and Automation, 1988
American Machinist, February, 1990

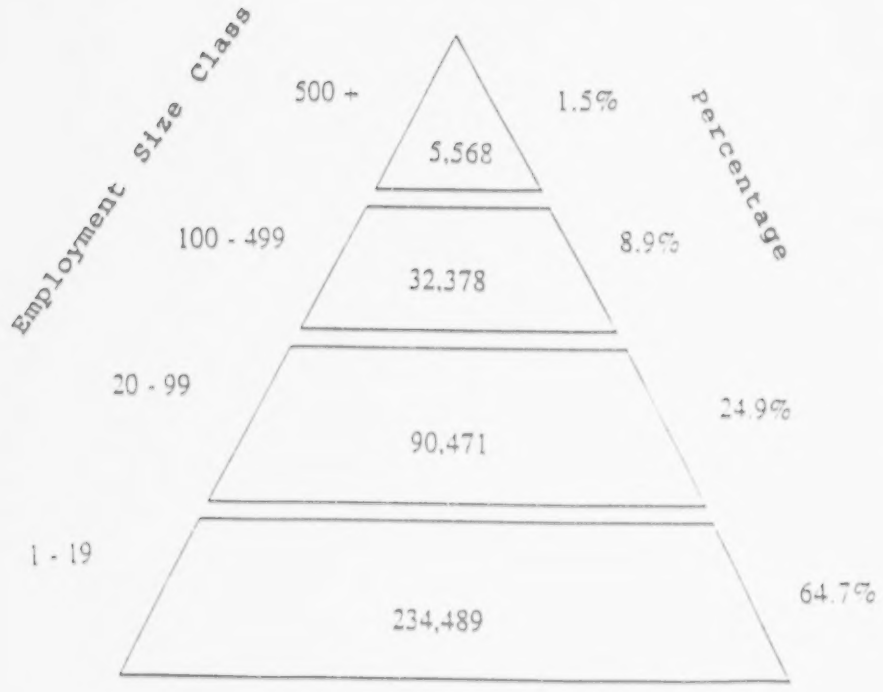
Fault lines in the supplier base: The some 350,000 small manufacturing establishments in America are, in general, poorly equipped to deal with the challenges of competition from increasingly sophisticated foreign suppliers. The relative productivity and earnings of these smaller firms have declined steadily throughout the 1980s, and they have fallen increasingly behind larger firms in plant modernization.

Their problems are a serious weakness for the entire manufacturing enterprise, since they produce about a third of the value added in U.S. manufacturing, they account for almost one half of the U.S. trade deficit, and large manufacturers are increasingly relying upon outside suppliers for discrete manufactured parts and components. Even though large firms are shrinking their supplier base and forming alliances with small, hi-tech firms, they are ultimately dependent upon tens of thousands of discrete parts makers and suppliers.

The enclosed pyramidial chart offers a picture of the important place that firms with fewer than 500 employees play in the total U.S. manufacturing base.

U.S. MANUFACTURING ESTABLISHMENTS

(SIC 20 - 39)
Total: 362,906



U.S. Bureau of the Census, 1988
Figures published December 1990

Workforce Skills: Just as the demand for a highly-skilled workforce in manufacturing is increasing, the supply is decreasing. International comparisons consistently show U.S. students behind most other leading industrialized nations in science, math, and vocational skills. In many sectors, industry is experiencing grave difficulty in obtaining the services of skilled technicians and qualified workers, while over one half million of America's young people drop out of high school each year. Companies are now spending tens of billions of dollars giving basic remedial education that their employees should have learned in primary and secondary schools. The greatest danger to America's industrial strength is the lack of vision in dealing with these weaknesses in the manufacturing infrastructure. Our leading overseas competitors, of course, have some of the same challenges, but they typically enjoy:

- Greater access to capital at lower interest rates.
- Stronger new plant and equipment investment incentives, especially for small to medium-sized manufacturers.
- An education and training base more conducive to the needs of industry.
- A greater percentage of government funding devoted to civilian R&D.
- National industrial extension and networking programs for smaller firms.

Companies alone can not solve these structural problems. Only a vigorous national effort at all levels—in companies, schools, Federal, State, and local government agencies, financial institutions, associations, unions—can succeed in correcting these deficiencies. If that is accomplished, then U.S. manufacturers will enjoy a public policy environment more conducive to higher levels of productivity, quality, and competitiveness.

What is particularly worthy of the attention of this committee is the role that the Federal Government should play in that larger national effort to rejuvenate America's industrial infrastructure., including the infrastructure for defense production.

STRATEGY FOR FEDERAL ACTION

The National Coalition for Advanced Manufacturing (NACFAM), has proposed a strategy for federal action in its recently-published White Paper, *Industrial Modernization: An American Imperative.*

This paper resulted from recommendations emerging from conferences and meetings organized by NACFAM for over a year. It crystallizes private sector views from all corners of the coalition: from manufacturing firms of all sizes; centers of manufacturing research, education, and training; State economic development agencies and industrial extension services; national trade, vocational, and educational associations; and other members of the Nation's manufacturing enterprise. As an organizational strategy, NACFAM, an action organization, has formed a network of these various players in the field of industrial modernization.

The measures proposed in this paper are well within the bounds of the practicable. Our approach is evolutionary, not revolutionary. We are not recommending massive organizational changes, such as the creation of a MITI-like Department of Industry and Technology or a "civilian DARPA." Instead, we are trying to build upon successful programs with high potential that are already in place. Nor are we suggesting extensive new funding. We propose instead reprioritization and reallocation within existing funding levels.

NACFAM is not suggesting an "industrial policy," with its connotation of a centrally-directed, planned industrial economy that picks winners and losers among various product lines. What we do suggest is that the Federal Government do better in the areas in which it already has major and, in some cases, unique responsibilities. In conducting its existing programs and in its day-to-day management of its economic and technology policies, the Federal Government should be more attentive to the impact of its actions on the performance of U.S. industry in the global economy.

Above all, the Federal Government needs a broad strategy to coordinate, prioritize, and direct its existing programs in order to facilitate the modernization of the nation's industrial infrastructure. The four cornerstones of the Federal strategy proposed by NACFAM are the following:

- Leadership
- Technology Development and Diffusion
- Human Resource Development
- Targeted Modernization Incentives

I will discuss some of the specific measures which we envisage in each of the areas and note progress achieved to date to implement these measures.

LEADERSHIP

A concerted Federal effort to reinvigorate the Nation's industrial infrastructure cannot be successful without Presidential leadership. One important step which the President could take would be to deliver a major address, hopefully in the first half of 1991, on industrial competitiveness.

Some specific measures that he could announce include the following:

- Set a goal for industrial competitiveness—such as the modernization of the Nation's industrial infrastructure by the year 2000—and undertake a continuing effort to explain the importance of that goal for the Nation's standard of living and economic security.
- Create a National Commission on Strength in Manufacturing to review periodically progress toward that goal.
- Designate an annual "U.S. Manufacturing Week" to provide a yearly focal point for the public recognition of achievement in quality manufacturing and training.

Since these measures are critically dependent upon the attention of the President and congressional leaders, their understandable preoccupation with the Gulf war has recently limited the prospects for early, dramatic progress in these areas. Nevertheless, there are some encouraging signs of progress:

- Both parties are now giving high priority to economic growth. In his March 6 Address to Congress on the end of the Gulf war, President Bush stated, "Our first priority is to get this economy rolling again" In his response to the President's January 29 State of the Union Address, Senate Majority Leader George Mitchell said, "Our first priority must be economic growth."
- NACFAM has received an excellent reception from leadership levels both in the administration and in Congress to its White Paper, and implementation actions plans are underway.

Yet, despite these encouraging indicators, much stronger national leadership will be required, from both the administration and the Congress if the United States is to rebuild its manufacturing infrastructure to world-class standards.

TECHNOLOGY DEVELOPMENT AND DIFFUSION

Modernization of the Nation's industrial infrastructure requires the continuous development of advanced manufacturing process technologies. Just as importantly, it requires the deployment of these technologies—especially readily-available, off-the-shelf technologies—to manufacturing firms of all sizes, but especially to small and medium-sized firms, who are generally less aware of new production technologies than are large firms.

To effect these changes, we propose the following action measures by the Federal Government:

- Revise priorities in federal R&D programs to provide for significantly greater proportion of funding for manufacturing technologies.
- Improve government mechanisms for commercializing manufacturing technologies developed under these Federal R&D programs.
- Assist in funding State and local industrial technology extension programs, particularly those programs that are aimed at diffusing readily-available, off-the-shelf, advanced manufacturing technologies to small and medium-sized manufacturers.
- Establish endowed chairs for professionals with industry experience to be established in community colleges, universities, and other manufacturing education and training centers in order to improve outreach into the local manufacturing community.
- Strengthen Department of Defense quality manufacturing programs and promote the wider use of manufacturing extension programs for defense suppliers.

Progress will be difficult in this critical field. As noted above, Federal funding for advanced manufacturing technologies research was slightly reduced in the administration's proposed fiscal year 1992 budget, and there is little funding for deploying those technologies into the Nation's industrial base. Nonetheless, a certain amount of groundwork has been laid for implementing the measures proposed above.

- Reactions on the Hill have been favorable thus far to the elements of an Omnibus Manufacturing Technology bill prepared by NACFAM that would embrace most of the actions proposed in the White Paper. Funding would be based upon reprioritization of existing R&D funds and through specifying that agencies should use a portion of their tech transfer funds to facilitate the deployment of manufacturing technologies through state and local centers. The NACFAM proposal envisages eventual assistance to 300 centers.
- Two new programs at the National Institute for Standards and Technology (NIST)—the Advanced Technology Program (ATP), to facilitate industry-government consortia in manufacturing technologies, and the Manufacturing Technology Centers (MTC) program, designed to facilitate the transfer of manufacturing technologies—now appear well-established. Although these are still small programs, they have the potential to become significant agents of industrial modernization.
- The fiscal year 1991 Department of Defense authorization bill created a new Defense Manufacturing Technology Enhancement program, which received $50 million in new funding, to facilitate the diffusion of such advanced defense manufacturing concepts as computer-aided acquisition and logistics systems (CALS), product data exchange specification (PDES), concurrent engineering (CE), and rapid acquisition of manufactured parts (RAMP). (It should be noted, however, that the administration's fiscal year 1992 budget proposal requested no additional funding for this program and reduced funding for the important Manufacturing Technology (MANTECH) program).
- A new manufacturing technology access service, to be provided to smaller firms through Small Business Development Centers (SBDCs), will be started on a pilot program basis in five States this year.
- A proposal for endowed chairs for industry professionals at education-training centers is now under review in Congress.

HUMAN RESOURCES

Although the Federal Government does not play the lead role in education and training, it does provide leadership in this field and serve as a stimulus for sound practices at the State, local, and corporate level. In the field of industrial modernization, the Federal Government can take several useful steps to aid in upgrading

the skills of the Nation's workforce. NACFAM has proposed the following measures, which represent only a modest effort in this largely neglected area:

- Expand the "Tech Prep," Two-Plus-Two program initiated by the Perkins Vocational Education Act of 1990. This innovative program will help fund vocational development programs that combine the last 2 years of high school with the first 2 years of college in order to graduate individuals with highly-developed skills in a single technical field.
- Identify the best human resource programs currently operating at State and local levels in order to facilitate their replication on a nationwide basis, including the use of interactive multimedia programs.
- Strengthen the Labor Department's pilot work-based learning programs to improve workforce quality.
- Make a national commitment to win the International Skills Olympics.
- Establish a "Charlottesville Industrial Specialist Skills Award" for high school graduates to mark the commitment of the President and the Nation's governors at the 1989 Charlottesville Education Summit to raise America's workforce skills to internationally competitive levels.

Some progress has been made on these issues. For example:

- The Tech Prep program was authorized for the first time and received a $61 million appropriation. Language in the administration's fiscal year 1992 budget proposal supported the growth of this program.
- The Labor Department's pilot work-based learning program, which provides models for apprenticeship training somewhat similar to the highly successful German system, is receiving increasing attention and support.

A much greater effort is needed in this critical area. The Federal Government needs to strengthen its collaboration with States, cities, unions, and industry to raise the skill levels of the American workforce.

TARGETED MODERNIZATION INCENTIVES

The Federal Government plays a critical role, through its control of fiscal and monetary policy, in incentivizing manufacturing industries to invest in new plant and equipment. These investments, if joined with sound business-management strategies, can deliver timely increases in productivity and quality. As an economic basis for this view, allow me to cite Nobel Laureate Lawrence Klein:

"Broadly speaking, I have characterized the United States as a high consumption-low savings economy. We should be encouraged to become a high savings-high investment economy. Tax reform was poorly structured by taking away investment incentives in the form of tax credits and accelerated depreciation. Those features should be restored as quickly as possible because physical capital formation is an important source of technological improvement. It is simultaneously anti-recessionary and helpful for resorting competitiveness."

In making its recommendations in this area, NACFAM has selected incentives that are carefully aimed at factory modernization. While not opposed to the capital gains tax reduction, NACFAM believes that the following, targeted measures would have a stronger, more direct impact on increasing industrial productivity growth:

- A 10 percent modernization tax credit for new or refurbished plant and equipment, both hardware and software; an additional 5 percent credit for this purpose to be granted to small manufacturing firms with fewer than 500 employees; a 5 percent modernization credit to qualified manufacturing companies that have realized a demonstrable productivity gain of 5 percent or more during the previous tax year period.
- An acceleration of cost recovery for productivity-enhancing equipment through the inclusion of all computer based manufacturing equipment as qualified technological equipment under section 168 of the Internal Revenue Code and the reclassification of all such equipment as 3-year property; the accelerated expensing of qualified manufacturing process equipment under section 179 of the Internal Revenue Code, in exclusion amounts not exceeding $75,000.
- The creation of a secondary financial loan market for industrial modernization investments, on either a purchase or lease basis.
- Improved Small Business Administration loan programs for purchasing advanced manufacturing equipment.
- Incentives to the defense contracting community to increase their efficiency and their ability to compete more effectively in commercial markets through reducing the current obstacles to commingling civilian and military production and acquiring flexible computer-integrated manufacturing technology.

• Encouragement to the accounting community to revise generally accepted principles of accounting to reflect the benefits of advanced manufacturing and the appropriate norming of IRS regulations to these new accounting methods.

These are all major measures, which will require a considerable effort to achieve, especially given the likely difficulties in effecting significant changes to the tax code in 1991. Nonetheless, there are some promising signs:

• The administration is giving serious consideration to reducing the accelerated depreciation schedule for productivity enhancing equipment from 5 years to 3.

There is substantial interest in some key congressional committees in the idea of a secondary loan market for industrial modernization investments.

• The Small Business Administration has drafted language to amend the section 504 loan program to authorize SBA loans for new manufacturing equipment purchases.

• The Senate version of the revisions to the Defense Production Act would amend the Federal Acquisition Regulation to provide incentives in acquisition contracts for firms to acquire "modern industrial facilities and production systems (including hardware and software) and other modern production equipment that increase the productivity of the offerors and reduce the costs of production."

Amending Pentagon procurement policies—especially the obstacles to buying products using commercial specification—to permit greater commingling of civilian and military production is a perennial problem. Progress in this area would be a major step toward making more rational use of finite resources and modernizing and streamlining the Nation's defense industrial base. This would both reduce production costs and increase the flexibility of U.S. industry to respond effectively both to military security and economic competitiveness requirements.

ROLE OF CORPORATE MANAGEMENT

The strategy proposed above focuses on appropriate actions that the Federal Government might take to reinvigorate the U.S. industrial base. Even the full implementation of the entire set of measures proposed for this strategy will do no more than improve the environment in which U.S. firms themselves must be competitive.

There are many critical reaches within the corporate world in which government will have and should have little or no effect. One of the most crucial is management. Management decisions will have the greatest impact on U.S. industrial competitiveness. In the field of factory modernization, it will be the role of management, for example, to:

• Utilize quality production as a strategic initiative to improve the competitive position of the company.

• Strengthen the role of manufacturing operations as a full and equal partner in the corporate structure.

• Give greater attention to process, not just product, technologies.

• Make astute investments in plant modernization, ensuring that an organizational and training framework is in place to make optimal use of new production process technologies.

• Adopt concurrent engineering approaches, simultaneously designing products and processes to make them.

• Ensure that all key corporate executives understand the limits and possibilities of manufacturing processes.

While the Federal Government can not effect those decisions directly, it can try to stimulate quality, competitive manufacturing in limited ways. A classic example is the Malcolm Baldrige National Quality Award, which has done a remarkable job in creating a climate for quality in American industry. Other steps which the Federal Government could take to encourage management include:

• Making "Total Quality" the number one priority in government procurement of goods and services.

• Introducing quality management into government, moving toward performance-based budgeting and building upon the role of the Federal Quality Institute and the initiatives by the President's Council on Management Improvement and the OMB.

CONCLUSION

A national effort to strengthen America's industrial base will require a commitment at all levels of the manufacturing enterprise. The President can spark such an effort and the Federal Government can play a key role in improving the environment for productivity, quality, and competitiveness. The most important responsibilities fall upon the private sector, especially corporate management.

None of the individual steps proposed above, whether taken by government or industry, can redress all the structural weaknesses in the Nation's industrial infrastructure. However, the cumulative impact of progress in all these areas has the capacity to transform American industry and to ensure that, as a Nation, America is making optimal use of its resources for industrial production.

From this position of industrial strength, the United States will enter the 21st century with full confidence that it can deal with the full range of economic, military, and social challenges it will confront.

[Whereupon, at 11:48 a.m., the hearing was adjourned.]

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